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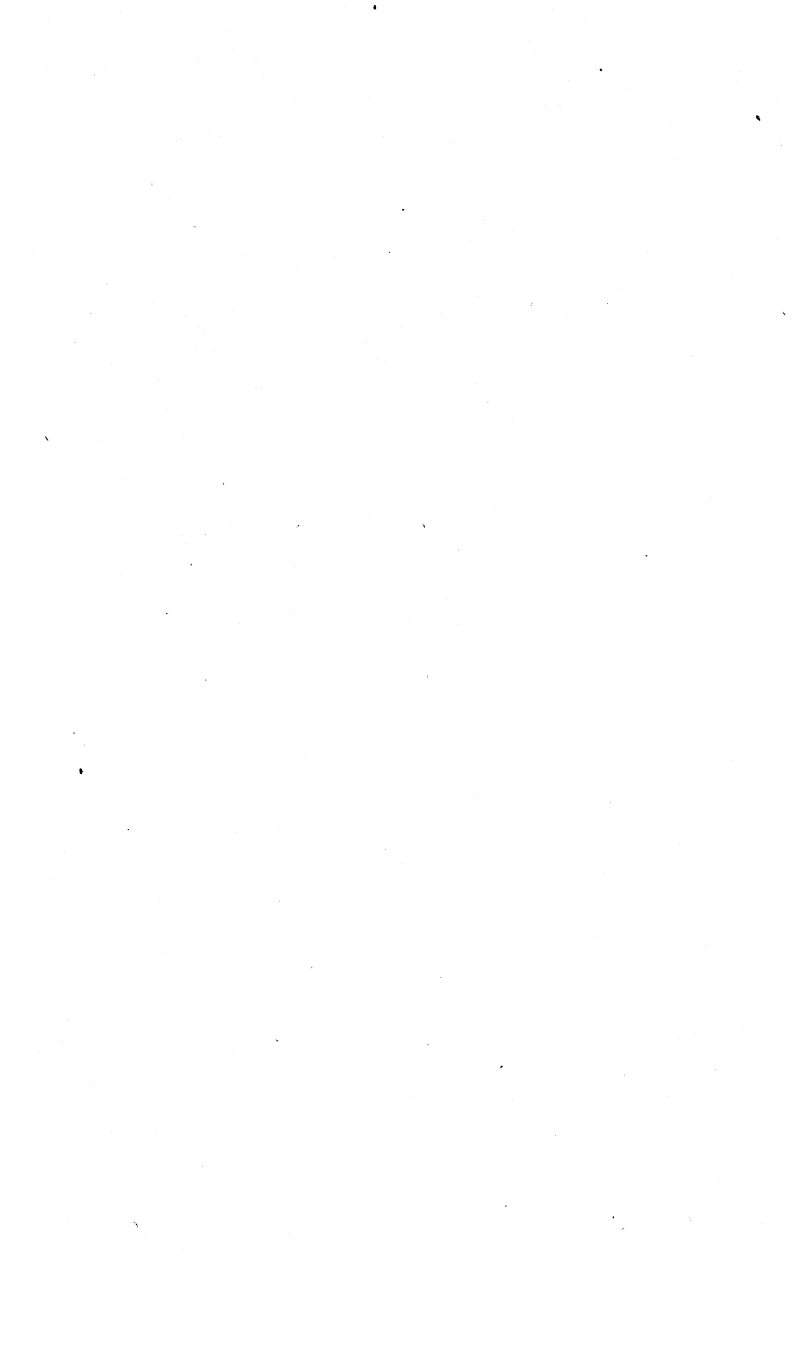
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# PETROLEUM AND ITS PRODUCTS:

AN ACCOUNT OF THE

HISTORY, ORIGIN, COMPOSITION, PROPERTIES, USES, AND  
COMMERCIAL VALUE, &c.,

OF

## PETROLEUM,

THE METHODS EMPLOYED IN REFINING IT, AND THE  
PROPERTIES, USES, &c., OF ITS PRODUCTS.

BY

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LONDON

JOHN W. DAVIES, 54, PRINCES STREET,  
LEICESTER SQUARE.

LIVERPOOL: H. GREENWOOD, 32, CASTLE STREET.

1863.



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LIVERPOOL:  
PRINTED BY HENRY GREENWOOD, CASTLE STREET.

## PREFACE.

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PETROLEUM has now become a very important article of commerce, and information concerning it is much required, especially as many erroneous opinions respecting its properties, &c., are prevalent. A large amount of information is scattered through the pages of our numerous periodicals; but there does not exist, as far as I am aware, any work specially devoted to the subject of Petroleum. In order, therefore, to supply, to some extent, the want which was felt for such a work, I have prepared this small book, which I trust may be found useful in diffusing a knowledge of a very interesting and valuable substance. It is impossible, in a small volume like this, to include all that is known of Petroleum, especially as every day is bringing to light new facts concerning it; but I have endeavoured in the following pages to give as complete an account of the crude Oil, and its various products, as my space would allow. To those who wish to keep themselves well posted up on the subject, I would recommend a perusal

of some of our standard periodicals ; and, amongst others which I have found to contain the most reliable information, and which I have largely availed myself of in preparing this book, I may particularly mention the *Pharmaceutical Journal*, *Chemical News*, *Technologist*, and *Oil Trade Review*.

In conclusion, I would acknowledge, with thanks, the kindness of those gentlemen who have assisted me in obtaining information. To Messrs. Holt and Banner, of this town, I am particularly indebted, not only for the information which they have given me, but also for a large number of samples of Petroleum and products, which have been of great use to me in my analyses, &c. I am also indebted to Alexander S. Macrae, Esq., a gentleman well known in the Petroleum trade, for several samples which he kindly supplied to me for the purpose of illustrating a lecture, which I delivered on the subject at the Liverpool Free Public Library, in December last. These samples have been of much service to me in my examinations.

A. NORMAN TATE.

LABORATORY, 79a, LORD STREET, LIVERPOOL,  
*July 28th, 1863.*

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# PETROLEUM AND ITS PRODUCTS.

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## CHAPTER I.

### HISTORY.

PETROLEUM KNOWN TO THE ANCIENTS.—DEAD SEA.—WELLS IN THE IONIAN ISLANDS, AND THE ISLAND OF ZANTE.—PAGAN FIRES.—ITALIAN AND SICILIAN SPRINGS.—WELLS IN PERSIA.—RANGOON OIL.—PETROLEUM KNOWN TO THE EARLY FRENCH SETTLERS IN AMERICA.—OLD WELLS AND APPARATUS, DESCRIBED BY DR. HILDRETH IN 1836.—GEOLOGICAL REPORTS OF WESTERN CANADA.—DEPOSITS OF BITUMEN AT ENNISKILLEN.—COMMENCEMENT OF THE PRESENT TRADE.

THE existence of petroleum is no new discovery, as it was, without doubt, known and used for various purposes at least 4,000 years ago.

The earliest evidence of the existence of petroleum is to be found amongst the ruins of Nineveh, in the building of which city an asphaltic mortar was employed—the asphalt being obtained by the evaporation of petroleum. In the construction of another ancient city—Babylon—*asphaltum* was likewise used: the petroleum in this case being obtained from the springs of *Is*, situate about 120 miles above Babylon, on the banks of the river *Is*, a small tributary of the Euphrates. These springs attracted the

attention of Alexander, of Trajan, and of Julian; they are in existence at the present time, and the petroleum procured from them is largely used in the neighbouring villages for illuminating purposes.

A substance obtained from petroleum was employed by the Egyptians in embalming their dead.

The existence of petroleum in the Dead Sea has been known from time immemorial. The bituminous matter is found in the centre of the sea in a liquid state; but upon the banks it is in hard compact masses, which, probably, have been formed by the evaporation of the liquid.

On one of the Ionian Islands there is a spring which has yielded petroleum for more than 2,000 years. Herodotus speaks of the wells of Zacynthus—the modern Zante; and Plutarch describes a sea on fire, or lake of burning petroleum, near Ecbatana.

The perpetual fires that burnt at pagan shrines are supposed to have been caused by springs of mineral oil inflamed at the surface.

Pliny and Dioscorides mention the petroleum of Agri-gentum, in Sicily, which was used in lamps under the name of "Sicilian oil." Petroleum obtained from the springs of Amiano, in Italy, was formerly employed for lighting the city of Genoa.

The springs of Bakou, in Persia, in the vicinity of the Caspian Sea, are widely celebrated, and have yielded immense quantities of oil.

The petroleum springs of Rangoon, on the banks of the Irawaddi, in the Burman Empire, are said to have been known and worked for ages, and are at the present

time some of the most powerful and copious springs yet discovered. In this locality there are not less than 520 wells, yielding annually 400,000 hogsheads of oil.

The existence of petroleum in America is by no means a new discovery, although it is popularly supposed to be so. There can be no doubt that it was known to the early French settlers, and to the Indians of Western Pennsylvania. Ancient oil wells and apparatus have been discovered in Western Canada and Pennsylvania, affording undoubted evidence of human works of great antiquity. Between the mouth of Oil Creek and Titusville, Pennsylvania, old vats are to be seen, and large trees are now growing upon the earth thrown out in sinking the pits to collect the oil, which flowed from the springs.

The Seneca Indians have long been acquainted with petroleum, and the "Seneca" or "Genesee oil" has long been known, collected, and employed for medicinal purposes, as also has the substance known as Barbadoes tar.

Petroleum springs, yielding from 50 to 100 barrels of oil annually, were mentioned by Dr. Hildreth as existing in the year 1836 in the valley of Little Kanawha, Virginia. Mr. Murray, a Canadian geologist, pointed out, in the year 1844, the existence of liquid bitumen in the corniferous limestone of Western Canada. It is likewise mentioned in the geological reports of Western Canada for the years 1850, 1851, and 1852.

It was in the year 1853 that attention was attracted to the deposits of bitumen at Enniskillen, in Canada, and in the year 1857 Mr. W. M. Williams, of Hamilton, commenced with some others the distillation of the tarry

bitumen; but they soon discovered that by sinking wells in the clay beneath they were able to obtain large quantities of a similar material in a fluid state. Numerous wells were then sunk in the vicinity of Enniskillen, and large quantities of oil obtained.

The year 1859 may, however, be said to have seen the commencement of the present trade in petroleum. In the month of August in that year a spring of oil was "struck" at Oil Creek, in Venango County, Pennsylvania, by sinking an artesian well to the depth of seventy feet, and for many weeks 1,000 gallons per day were obtained from it.

The news of this discovery soon spread, and a large number of persons flocked to the vicinity; and before the close of 1860 100 wells had been bored, many of which yielded large quantities of oil, but many others, from having been sunk at random, were quite unsuccessful.

From that time to the present the trade has rapidly increased to an enormous extent, and now bids fair to become one of the most important in the world.

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## CHAPTER II.

### WHERE AND HOW OBTAINED.

LOCALITIES WHERE PETROLEUM IS FOUND.—MEANS OF OBTAINING THE OIL AT RANGOON.—SINKING OF WELLS IN AMERICA.—DESCRIPTIONS OF OIL WELLS.—SHAW'S WELL.—QUANTITY OF OIL YIELDED BY DIFFERENT WELLS.—MEANS OF CARRYING THE OIL FROM THE WELLS TO THE SHIPPING PORTS.—SUPPLY.

SEVERAL places have already been mentioned where pretroleum is obtained, in fact it is found in every quarter of the globe.

In Europe there are the English and Scotch springs; the springs of Neufchatel, in Bavaria; of Amiano and St. Zelo, in Italy; Clermont and Gobian, in France; those existing in the Ionian Islands and in Sicily; and in several other parts.

In Asia there are the springs of Bakou, in Persia; the Rangoon springs, in Burmah; the Dead Sea; the springs of Hit; and in several islands of the Indian Archipelago; and in China petroleum is met with.

It is also obtained from Africa. A few years ago petroleum was imported into Liverpool from Africa, but owing to the large quantities coming from America, it was thought not worth while to bring it from Africa. Within the last few months, however, more of this African petroleum has made its appearance here.

Through the kindness of Messrs. Holt and Banner, of Sweeting Street, Liverpool, I have been favoured with a specimen, a description and analysis of which will be found on a later page.

The occurrence of petroleum in Africa is mentioned by Dr. Livingstone in his "Missionary Travels in South Africa."

It is, however, in America that the largest quantities of petroleum are found. Petroleum is probably more generally diffused in America, particularly in the United States, than is supposed. It is now procured in New York, Kentucky, Virginia, Ohio, and Pennsylvania; also in Texas, Canada, Nova Scotia, New Brunswick, Newfoundland, and even on the banks of the Mackenzie River. Explorations and the sinking of wells have likewise been commenced in Alabama, Georgia, Tennessee, and Maryland.

Petroleum is likewise found in many parts of Central and South America. The springs of Havana have been known to the Spaniards ever since their first settlement in that country.

The pitch lake of the Island of Trinidad is widely celebrated. It is upwards of three miles in circumference, and is situated at the head of La Brae harbour. Dr. Gesner thus describes it:—"The bitumen, of the consistence of thin mortar, was flowing out from the sides of a hill, and making its way outwards over more compact layers towards the sea. As the semi-solid and sulphurous mineral advances, and is exposed to the atmosphere, it becomes more solid, but ever continues to advance and

encroach upon the harbour. The surface of the bitumen is occupied by small ponds of water, clear and transparent, in which there are several kinds of beautiful fishes. The sea, near the shore, sends up considerable quantities of naphtha from subterraneous springs, and the water is often covered with oil, which reflects the colours of the rainbow."

Large quantities of petroleum have also been discovered in California.

#### HOW OBTAINED.

Different methods are employed for obtaining petroleum. At Rangoon the plan adopted is exceedingly simple. The wells are situated about two miles from the village of Yak, near Goung, where they occupy a space of about twelve square miles; they are from 200 to 300 feet deep, of small calibre, and sustained by scantling. The temperature of the oil when first raised averages about 89° F.

An earthen pot is lowered into the well, and drawn up over a beam placed across the mouth by two men running off with the rope until the pot comes to the top. The pot is emptied into a little pool, where the water with which it is mixed settles to the bottom, and the oil is drawn or skimmed off from the top. It is exported in earthen jars containing about 30 lbs. each, but it has also been brought to this country in vessels of about 1,000 tons burthen, fitted with iron tanks. A single well yields from 1,200 to 1,500 lbs. per day, but sometimes as much as 2,000 lbs. per day is obtained, the amount depending

to some extent upon the quantity of water drawn up with the oil. Each well is worked by three or four men.

Both at Rangoon and in some parts of the American oil regions the earth is saturated with oil, and wells or deep pits are dug into which the oil oozes, and is then dipped or pumped out, and placed in casks or other suitable vessels.

Some of the porous limestone of Western Canada is so saturated with oil as to yield profitable results when subjected to distillation.

The oil, however, especially in America, is generally found stored in fissures in the rocks, and these fissures are more vertical than horizontal. The lowest part of the fissure contains water, above that is oil, and the highest portion contains gas. The accompanying diagram will explain this.

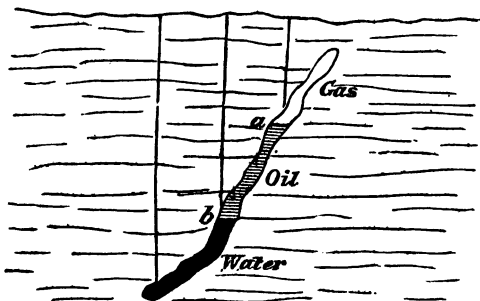


FIG. 1.

If the well strikes the lower part of the fissure the water is forced up by the pressure of the supernatant oil and gas. If the well strikes any point between *a* and *b* the oil is forced up, and of course if the well is bored

into the upper portion of the fissure only gas is obtained. Wells have frequently been abandoned when it has been found that water was obtained instead of oil; but if the water had first been removed, by pumping, a supply of oil would have been procured.

The oil is met with at various depths. Dr. Gesner states that the average depth at which oil is obtained has not yet exceeded 250 feet. It is probable that deeper sinking may hereafter be found profitable.

In some cases an abundant supply of oil is obtained at 40 feet deep, whilst at other places in close vicinity the oil is not met with until a depth of from 120 to 160 feet has been attained, and sometimes even then only in small quantities. The wells of Mecca, in Trumbull County, Ohio, are sunk from 30 to 200 feet, in a sandstone saturated with oil. The wells of Titusville, in Oil Creek, Pennsylvania, are bored from 70 to 300 feet.

The figure shows the relative depth of the wells at Burning Spring Run.

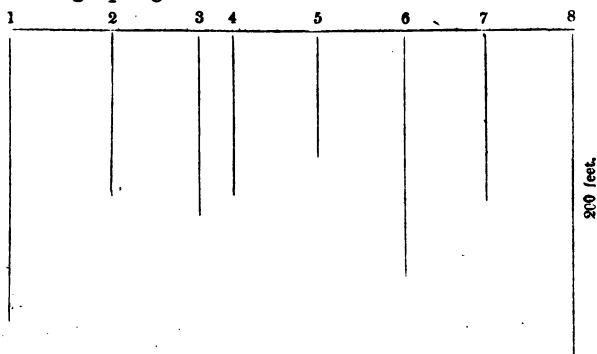


FIG. 2.

The manner in which the wells are sunk is as follows:—A hole of from four and a-half to five feet in diameter is first dug in the soil, until the rock is reached, the sides of the hole being cribbed up with timber to prevent them falling in. When the rock is reached, a hole of three or four inches diameter is bored into it for about ten or twelve feet, and into this hole an iron pipe is inserted. The drill is next introduced. The cutting portion is of steel, shaped like a common chisel, welded to a round bar of iron nearly as large in diameter as the iron pipe into which it is placed, and weighing from 200 to 300 lbs.

The drill is suspended by a rope from the beam overhead. In order to continue the boring it is necessary to get a reciprocating motion, and the object has been attained in this way:—An upright post is erected by the side of each well. Across the top of this post is placed a tapering spar, the thick end being fastened to some tree at a convenient distance, or, if none such can be found, a weight is attached to the end; but more generally, care having been taken to secure a spar heavy enough for the purpose, no additional weight is required. It is now evident that if the end next the well be bent the spar will right itself the moment the pressure is removed, and that the desired motion may thus be obtained. Accordingly, the rope attached to the drill is fastened at a distance of about three feet from the end of the pole. From the extreme end hang ropes with stirrups, into which the workmen place their feet, and, by alternately pressing and removing the pressure, the drill is lifted a distance of six,

eight, or ten inches, as the case may be. Day after day the workmen thus "treddle," until the oil is reached. When, after boring for a given time, the men think that so much rock has been loosened as to render it necessary to clear out the hole, the drill is wound up to the top by means of a windlass, and the sand-pump lowered. This pump is merely an iron tube, with a valve at the bottom opening inwards. When let down into the bore the valve is forced open by coming in contact with the pounded rock, which gets to the inside. As soon as it is raised the contents of the tube pressing on the valve close it, and so imprison themselves within. The sand pump has to be used, when going through soft rock, many times a day.

The average price charged for boring is by contract 8s., or two dollars a foot for the first one hundred feet; for the second, 12s. per foot; for the third, 16s. A distance of from 3 to 4½ feet is generally made per day. Each 100 feet requires an additional man to work the drill, and after a depth of 300 feet has been reached, a steam engine is generally employed.

When the oil is "struck," the pressure of the gas forces it up, and it flows for some time without the aid of a pump. When the oil has ceased flowing, an iron pipe is inserted into the hole in such a manner as to prevent any surface water from entering the well. To this pipe a pump is attached, which is worked either by hand or by steam power.

The steam pumping apparatus is exceedingly simple. It consists of a small horizontal engine connected by its

piston to a crank which gives motion to a vibrating wooden beam, one end of which is attached to the vertical pump rod in the well, which is thereby set in action, and lifts the oil in the same manner as an ordinary pump lifts water.

The oil and water are pumped into large vats, holding 100 barrels each; the oil floats on the surface, and the water is drawn off from beneath.

A rude derrick, a rough shed, a small steam engine, a pump, and a few barrels and tubs, constitute the whole of the apparatus and utensils required for working these wells.

Numbers of these wells are to be seen on both sides of the Ohio and Alleghany rivers, and also in some of the small islands. Many of the pumping wells have been abandoned owing to the discovery of the flowing wells, of which there are a great number, especially in the Oil Creek region, Pennsylvania. So great is the discharge of oil in some cases that a sufficient number of vessels cannot be obtained for its reception, and it runs in greasy streams over the surface.

The following extract from the *Toronto Globe*, of September 7th, 1861, gives an interesting description of the oil wells:—

“The oil veins are exceedingly capricious. The distance of the rock from the surface may be predicted with some certainty if experience be taken as a guide; but there is no certainty as to the depth at which the oil will be found. It may burst through the gravel before the rock is reached; it may delay its appearance until the

persevering well sinker has penetrated to a depth of 250 feet. In Pennsylvania some of the best wells there, which produce the finest quality and the largest quantity of oil, are 500 feet below the surface. When the vein is first struck in a surface well, the lumps of blue clay are brought up to the top soaked in the blood-coloured fluid. Then the oil digger is in all his glory. He complacently turns his quid in his mouth, gives his hands another shove down his breeches pockets, and with face bright with smiles, oil, and perspiration, ejaculates as an interrogation, 'Beautiful, aint it?' Now, unless you have some near prospects of getting a share of the profits, it is not beautiful, neither in smell or looks, but exactly the contrary. It will not do to say so, however. Beautiful! Is it not worth six cents. (2½d.) per gallon, with every prospect of being worth twice as much this time next year? What should make it beautiful if that will not? According to the same authority, everything oily about the territory is beautiful. The nasty Black Creek—aptly named—as it winds its way slowly along its narrow channel, between banks covered with derricks and vats and well charred stumps, piles of barrels filled with the unctuous fluid, mounds of sand and clay, is beautiful in his eyes, because it smells of petroleum to his nose. 'Oil Springs' looks like a small edition of South Staffordshire, quite as dirty, and smelling a great deal worse. But there is this in its favour—a forty-eight or ninety-six hours' acquaintance with its odours, and the olfactory nerves become insensible to them. From all points of the compass, the creaking of the treddle by which the

drill is worked can be heard throughout the night. Every day brings its quota of wayworn, muddy travellers, who with bundles on their backs have stumbled through the dirt, climbed the stumps, and waded the ditches on the Wyoming and Florence roads. Many of them come to get employment, and they are sure of it; others come with dollars in their pockets, and in a few days they have added others to the large number of wells already sunk. There can be no doubt that if a good market can be found for the oil, of which there appears every probability, Oil Springs is destined to go ahead very rapidly. In addition to the refineries already existing, a New York house entertains the idea of founding another. Mr. Southern, the largest proprietor of oil springs (150 acres, Lot No. 18, Second Concession), sent to this house a sample of the Enniskillen rock oil, and it is pronounced by them to be the best they ever saw. The farm clearings around this portion of Enniskillen are few. Woods—huge, dark, and almost impenetrable, except by the aid of the axe—extend in every direction. But they are destined soon to give place to the homestead of the settler. Roads are now the only want; the nearest Great Western Railway Station is at Bothwell."

A description of the scene at one of the largest wells in the Enniskillen district will also give a good idea of what may be seen in the oil regions of Canada and the United States:—"Passing by the many wells on the right and left, we hastened to the great object of attraction—the *big spouting well*, belonging to Mr. Shaw. As we descended from the high land into the plots, our attention

was called by the admonition—‘no smoking allowed here’ (a caution not unnecessary, as a stream of oil has more than once been set on fire, and there are not sufficient men about to carry out the method adopted by the Chinese for subduing fire under similar circumstances, as mentioned by Father Imbert, who make a lake and empty the oil into the hole); then we saw a heterogeneous mass, in which were men, women, children, sleighs loading and unloading, barrels empty and barrels full, barrels clean from the cooperage, and barrels smeared from the well. Amid hundreds of spectators some men were making bung-holes in the new barrels, and others engaged in filling them, and still others clearing the passage, with every variety of noise and vociferation, while the busily employed and the wondering spectators were standing from one to six inches in a black, greasy matter—the mere waste of this extraordinary well, which, in making its way to the creek, covered the surface of the ground for many rods around with the oily stream. In different places this valuable but filthy-looking stuff was being carefully gathered up by the visitors, among whom was an aged negro, who was striving to fill the bottle in his left hand with an old shoe in his right hand, a hole in the shoe wasting as much as it gave, like the well itself. From the mouth of the well, where the oil is bubbling up in every direction, there is a perpendicular tube, some sixteen feet high, four inches in diameter, but reduced to three-quarters of an inch by a stop-cock at the top, from which the oil is conducted into six or seven large tanks, two of which will hold five hundred barrels. In each of

these tanks there is a tap, about four feet from the ground, whence, by means of a short hose or funnel, the barrels are filled, the bungs then driven in, and then rolled into the road to be carted away. An intelligent gentleman, in charge of the operations, informed me that were it possible to get barrels in sufficient quantities they could supply 1,500 barrels in twenty-four hours: and that, even now, after having diminished the size of the tube from four inches to three-quarters of an inch, they were filling upwards of 500 barrels daily. The waste cannot be calculated. All along Black Creek—it is said for nearly a mile—there is a foot of oil on the top of the ice, which parties are gathering up and selling for what it will fetch. There are already three or four refineries in the village, and the best refined oil is selling at 50 cents per gallon. We counted nearly 200 wells, some of which were being worked, and still others were being made. Large numbers of men were busily employed in digging, banking up, and boring, all eager to penetrate to the bowels of the earth for the hidden treasure. It struck us that this extraordinary well is a serious injury to other proprietors of wells, as friend Shaw can certainly undersell and out-sell them all. His yield is spontaneous and continuous; theirs is constrained, and must be raised at the expense of horse or manual labour. But the great difficulty is *getting it to market*. Teaming it to Wyoming station is so slow a process, though it is done from this one place at the rate of 500 barrels per day. It is therefore in contemplation to send it through iron tubes to the river Sydenham, at Dresden, and this it is said the state of the

country will permit. There is a descent of from fifteen to twenty feet from Victoria to Dresden; so that by means of a raised reservoir at the former place it may be forced along to vessels ready to receive it at the latter place."

The story of the discovery of Shaw's well, extracted from the *Toronto Globe* of February 5th, 1862, may not be uninteresting:—

"One of the elements of romance at all times has been the sudden elevation of individuals from penury to wealth and social consideration. Having settled to our own satisfaction that romance is not dead, we plunge *in medias res*—that is to say, into a certain deep well near Victoria, on Lot 18, in the Second Concession of the Township of Enniskillen. In that well a certain John Shaw centered all his hopes and expectations for many long months. Painfully did he dig, painfully drill, painfully pump, expending first cash and then credit, and afterwards his own muscles, on a wearisome task. Not a sign of oil did he find. His neighbours' wells were overflowing: he alone had received no share of the petroleum stream. The middle of last January found him a ruined, hopeless man, jeered at by his neighbours, his pockets empty, his clothes in tatters—as our neighbours across the line say—dead broke. Report says that on a certain day in January, he found himself unable to pursue his work—not to put too fine a point on it—his boots had utterly given out, and to enable him to paddle about in the wet and cold, a new pair was absolutely necessary. In fear and trembling, as we may suppose, John Shaw proceeded to the neighbouring store, and

having no money, asked—sad necessity—for a pair of boots on credit. Report sayeth not whether the refusal was kindly administered, in the spirit of self-defence which traders must sometimes fall back upon, or whether it was the purse-pride of the rich man looking down on his humble neighbour, but certain it is that the boots were refused to John Shaw, and he returned to his well a sadder man than he left it, protesting that he would work no longer than that day if success did not crown his efforts; he would cast the mud of Enniskillen from his old boots, and depart to more congenial climes. Moodily he took up his drill, and sternly struck it into the rock. Hark! what is that? A sound of liquid from the depths below, hissing and gurgling as it escapes from the confinement of centuries. Does it cease? No, see it comes, growing in volume every moment. It fills the pipe, it fills the well; still it comes. Five minutes; ten minutes; in fifteen minutes it has reached the top of the well; it overflows; it fills a tank; it overflows that; vain are all attempts to check its career; resistless, it pours in a mighty tide down the declivity into Black Creek, and is borne away by the waters to the St. Clair and the Lakes. Who shall attempt to describe the feelings of John Shaw at that moment? We shall not, for we do not know how he showed them. The bystanders have not recorded whether he wept, or whether he took off his hat and shouted hooray! Anything might be excused at such a moment. We suspect that, like a philosophic Yankee, he went to work to ‘save the ile.’ But the report of the flowing well spread like wildfire

through the settlement, and 'John Shaw's territory' became the centre of attraction. In the morning he had been 'Old Shaw;' if they had spelt his name with a P before it, they could not have described him more contemptuously. Now he was Mr. Shaw. Congratulations poured upon him; and as he stood there, all covered with oil and mud, up came the store-keeper who had refused him the boots. The man of trade appreciated 'the situation;' he bowed before the rising sun, or rather the flowing oil lamp, and, almost embracing the dirty luminary, he said, 'My dear Mr. Shaw, isn't there anything in my store you want? if there is, just say so.' What a moment for Shaw! We shall not record his answer—it was far too forcible to be polite. The well was then flowing at a rate impossible to test with accuracy; but afterwards, when the yield was controlled, it produced two barrels of forty gallons each in a minute and a half; which, at one cent and a quarter per gallon (the lowest rate at which the article has been sold), would produce 66 cents per minute, 39 dollars per hour, 950 dollars per twenty-four hours, and 296,524 dollars per annum, throwing off the odd cents and not counting Sundays. Neither the illustrious but unknown authors of the *Arabian Nights*, nor even Alexander Dumas, drew from their or his imagination a more sudden transformation than this of John Shaw—in the morning a beggar, and in the afternoon able to satisfy every want to be reached by money."

The *Oil Trade Review*, of April 4th, 1863, contains a paragraph recording the untimely death of Mr. Shaw,

the proprietor of the celebrated well. He was at his own request lowered into the well, a depth of fifteen feet, for the purpose of pulling up a piece of gas-pipe. He descended by means of a chain with a loop in which to rest his foot. After reaching the pipe he asked to be hauled up, but immediately after seemed to be struggling for breath, and instantly fell backwards into the oil and disappeared.

The amount of oil yielded by different wells varies considerably. From some of them not more than 10 to 20 barrels per day are obtained, whilst others yield as much as 200 barrels, and at Tidionte there are 17 wells yielding very nearly 10,000 gallons per day. One of these wells, when first opened, spouted the oil and water to the height of sixty feet. Another well, in Erie County, Pennsylvania, yielded as much as 300 barrels per day. At Mecca, in Ohio, there is a well said to yield 20,000 gallons per day, and at Titusville a well called the "Empire Well" gives 7,000 gallons per day.

Most of the works are extremely rude, and scarcely a well is worked to its full capacity. Much of the oil territory is in the forest, the fuel for generating steam is green, and the whole thing, in fact, is quite in its infancy.

It is difficult to say what quantity of oil is raised in the oil regions of America, but 150,000 gallons per day is probably too low an estimate.

The oil is generally conveyed from the oil districts to the shipping ports in boats. From the Oil Creek region boats convey it along the Alleghany river to Pittsburgh. These boats, if they may be so called, are simply large

boxes made of planks, and divided into cells forming tanks, which are made as tight as practicable. These floating tanks or boats, which are from forty to eighty feet long and two feet deep, are filled at the wells by means of leather hose; they are then closed up, and from ten to twenty of them formed into a fleet and floated down the Alleghany river. A large quantity of oil is transported in this manner, but some of it is carried in barrels.

Artificial freshets are employed to float the boats down Oil Creek to the Alleghany river. The water is collected at different points in large ponds, and at a given time the sluices are opened, and through the freshet thus produced immense quantities of oil are floated down, which, but for this contrivance, could not, without great expense, be got to market. The stream being very narrow, and the water necessarily shallow, it requires great care to navigate it with safety; and at every freshet large quantities of oil are lost. Only a short time since petroleum to the value of 100,000 dollars was lost by one of these freshets. When the first rush of water came twenty boats broke loose, and these swept a large number of others from their moorings, and fifty-six were wrecked. About 10,000 barrels were lost, and all the cargoes that were in bulk. One American paper estimates the loss by three consecutive freshets at 40,000 barrels, valued at 500,000 dollars.

A movement has lately been set on foot for conducting the oil from the wells to various leading points of the railway by means of pipes. It is stated that a two-inch pipe is now being laid down from Tarville to Plumer, a

distance of about two miles and a-half, and those concerned in the experiment feel confident of success.

The transportation of the oil from the oil regions will be further discussed in Chapter IX.

#### SUPPLY.

A question of great importance to the commercial prospects of the petroleum trade is that of a continuous supply.

This question, as far as it regards the supply of petroleum failing eventually, is not easily answered, as the results obtained by experience are somewhat contradictory, inasmuch as in some regions—as, for instance, at Agrigentum, in Sicily, and Derbyshire, in England—the wells have nearly or entirely ceased to yield oil; whilst in others—in Burnmah, Persia, and the Island of Zante—the oil wells, although they have been worked for ages, still give immense quantities of oil.

As far as the spouting or flowing wells are concerned, it appears extremely probable that at some time, sooner or later, the present supply may fail; indeed there is already abundant evidence of this. The famous Shaw's well already mentioned is an example, as this well, according to recent accounts, is now yielding far less oil than it did not long since. Several other wells might also be mentioned that have either ceased to flow altogether, or from which the supply is much diminished.

This, however, must not be considered evidence of the supply failing altogether, or even becoming less than the demand, and for this reason:—when the wells are first bored, the oil is forced up by the enormous pressure

exerted by the large quantities of gas which always accompany the oil; but as soon as this pressure is removed, by reason of the escape of gas, the oil ceases to flow. This, no doubt, is the reason of the stoppage of the flowing wells. Many of these wells have been abandoned as soon as they ceased to flow, because it is cheaper to collect the oil from flowing wells than to obtain it by pumping.

If, however, pumps are inserted into these wells, there is no doubt, judging from experience, that a good supply of oil may still be obtained; and what is also of consequence, the supply will be more regular, and the oil of more uniform quality than at present.

Should the oil at any time fail, there is no probability of its doing so just now. The petroleum region of America embraces a very considerable area. It is known to extend from the southern extremity of the Ohio valley in the South, to the Georgian Bay, in Western Canada, in the North; and from the Alleghanies, in Pennsylvania, in the East, to the Western limits of the bituminous coal fields, in the vicinity of the Missouri river. Oil has been found in Virginia, Maryland, Pennsylvania, New York, Ohio, Michigan, Kentucky, Tennessee, Kansas, Illinois, Texas, and California; yet up to the present time wells have been sunk in comparatively few localities, and many of these, as already stated, have been abandoned when they ceased to yield without pumping.

It is extremely probable that further investigations will discover petroleum in other localities.

We need not, therefore, be under any apprehension of a failure in the supply of petroleum for many years to come.

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## CHAPTER III.

### ORIGIN OF PETROLEUM.

**GEOLOGY.—THEORIES OF ORIGIN.—DISTILLATION THEORY.—COMPOSITION OF PETROLEUM AND COAL OILS COMPARED.—BITUMINOUS AND LIGNITIC SHALES.—SUPPOSED FORMATION OF PETROLEUM BY DECAY OF VEGETABLE MATTER, &c.**

THE origin of petroleum is a subject which has occupied the attention of many eminent chemists and geologists, and numerous theories have been propounded to account for the formation of this very important and interesting substance; but, notwithstanding the great amount of attention that has been paid to it, the subject is still one on which much difference of opinion exists.

It is not my intention in the following remarks to put forward any new theory of my own, or to adopt as the correct one any particular hypothesis that has been propounded by others. I shall simply give a brief description of the geology of petroleum, and make a few observations respecting the principal theories which have been propounded to account for the origin of these mineral oils.

#### GEOLOGY OF PETROLEUM.

The knowledge which we at present possess regarding the geology of petroleum is decidedly meagre and unsatisfactory, and there is plenty of scope for further investiga-

tions. It is much to be regretted that accurate records have not been kept of the different strata penetrated in boring the oil wells, as much valuable information might in this way have been obtained.

Petroleum is found in rocks of all ages, from the Lower Silurian to the Tertiary period inclusive. In Europe and Asia the sources are for the most part confined to the rocks of the Newer Secondary and Tertiary age, although they are not entirely wanting in the Palæozoic strata.

In America it is found in strata of a much older date, the rocks of the oil districts consisting of immense deposits of the Silurian, Devonian, and Carboniferous ages. The oil wells of the United States are for the most part sunk in the sandstones, which form the summit of the Devonian series; but the oils of Western Virginia and Southern Ohio rise through the coal measures which overlie the Devonian strata; while the wells of Ennis-killen, in Canada, are situated much lower, and are sunk in the Hamilton Shales, which immediately overlie the Carboniferous or Devonian limestone. In the Island of Barbadoes considerable quantities of petroleum are derived from the Tertiary strata.

It appears, therefore, that petroleum is not confined to any particular strata, and consequently there is no such thing as a petroleum rock, properly so called, as many persons imagine.

It has been already stated that the oil is found in fissures in the rocks, and that these fissures are more vertical than horizontal; and it should also be remarked

that these fissures probably extend through many different strata. The oil exists most plentifully in those regions where the strata has been most disturbed; and where, as a consequence, the largest number of fissures occur. The oil obtained in the same localities from different wells is frequently found to differ considerably in quality; and this leads to the conclusion that in these cases the oil is contained in distinct and separate fissures. At the same time it should be remarked, on the other hand, that it has frequently occurred that, when a new well has been sunk in certain localities, it has caused a considerable diminution in the supply from other wells previously existing in the neighbourhood, showing that the new well is supplied from the same source as the other wells.

#### THEORIES OF THE ORIGIN OF PETROLEUM.

The hypothesis to which I shall first direct attention is one which has met with the support of many of our most eminent chemists and geologists, and is, in fact, that most generally adopted. It supposes that petroleum has been produced by the slow distillation at low temperatures of coal and other bituminous minerals; and the fact that we are able to produce oils of a similar character by the distillation of coal, as for instance, by Young's process for manufacturing paraffin oil, gives good grounds for believing this hypothesis to be correct.

It may be well here to compare the chemical composition of petroleum with that of the oils produced by the distillation of coal at low temperatures.

As will be seen in the next Chapter, petroleum, as far

as it has yet been examined, proves to consist chiefly of the hydrides of the alcohol radicles, hydrocarbons homologous with marsh gas, and having the formula  $C_n H_{n+2}$ , which, as my chemical readers will know, indicates that they contain an equal number of equivalents of carbon and hydrogen *plus* two of hydrogen. Petroleum is also said to contain small quantities of benzole, toluole, and other hydrocarbons of the same series.

The coal oils also contain hydrocarbons of the marsh gas series, and likewise benzole, toluole, &c., besides several curious compounds of a basic character.

There is, however, this difference between the two oils, viz.:—the coal oils contain the hydrides in proportionally small quantity, and the benzole, toluole, &c., in proportionally large amount; whilst petroleum consists chiefly of the hydrides, and contains only very small quantities of the hydrocarbons of the benzole series; indeed if these hydrocarbons are present at all, they exist only in minute traces. (See next Chapter.)

Mr. Schorlemmer, in a recent paper published in the *Chemical News*, states that he has found benzole in petroleum; but it appears he employed in his experiments that product of petroleum known as “turpentine substitute,” which is the lighter portion of the oil. Now, there is no doubt that benzole may be found in all the “turpentine substitute,” but my own experiments lead me to believe that it does not naturally exist in petroleum, but is produced during distillation.

The difference which has just been shown to exist in the composition of the mineral and coal oils does not,

however, upset the hypothesis that petroleum may have been produced by the distillation of bituminous minerals at low temperatures. The proportion of hydrocarbons of the benzole series is much smaller in the oil distilled from coal at low temperatures, than it is in coal tar, which is produced at a much higher heat, and the quantity of the hydrocarbons of the hydride series is much greater; indeed the only substance belonging to this series which exists in any quantity in coal tar is paraffin. This appears to show that a difference in temperature produces different products, and leads us to suspect that at a still lower temperature than is employed in distilling the coal oils the hydrides would be produced in still larger quantity, and benzole, &c., in smaller amount, and a liquid having more the composition of petroleum obtained.

As to whether the difference which is found to exist in the relative amounts of the hydrides and the benzole series in the products obtained at high and low temperatures, is really owing to the influence of heat in determining the production of hydrocarbons of the one or the other series, or whether it is merely due to its influence in causing the decomposition of the hydrides, we have at present no certain evidence. Probably the latter is the case.

It is, however, probable that a liquid having the same composition of petroleum may be produced by the slow distillation of bituminous minerals at a still lower temperature than is generally employed in distilling the coal oils.

One objection urged against this distillation theory is

that when petroleum is found in the neighbourhood of coal, the coal itself does not appear to have lost any of its bituminous constituents. For instance, at Ritchie County, Virginia, where strata have been brought up by an uplift from several hundred feet below, seams of cannel and bituminous coal appear, which, if judged by the standard of Nova Scotia or English coal, have lost none of their bituminous qualities.

So also Professor Henry Rogers, in an able article in *Good Words* for May, 1863, in describing the Appalachian coal field, shows that the coal in that part of the region nearest the oil districts is far more bituminous than that which exists where no oil is found; but he supposes that in the one case the heat caused by subterraneous action has been sufficient to entirely expel all the volatile matters, whilst in the other the displacement has been less complete, the volatile matters, instead of being wholly dispelled, having escaped into the pores, crevices, and fissures of the overlying rocks. In the latter case the oil may have been derived from the underlying strata, and have thus rendered the coal more bituminous instead of less so.

It is very certain that in many cases petroleum has not been derived from coal, inasmuch as it is found in districts far removed from any coal measures: as, for example, in Canada, where the rock oil evidently proceeds from the lower seated Silurian and Devonian deposits almost exclusively; and indeed the oils found in the coal districts may have been derived from the same rocks, as it is known that the Silurian and Devonian black Carbonaceous

Shales pass under all the north western and western districts of the American coal measures. But it should likewise be mentioned that although petroleum is found where coal is absent, shales containing carbonaceous matter are known to exist in most cases in the neighbourhood, and these are as likely to have yielded the oil as coal itself.

In examining these shales found in certain petroleum districts, there does not appear to have been sufficient care exercised in carefully distinguishing between those rocks which contain ready formed bitumen, soluble in benzole and bisulphide of carbon, and those which consist of argillaceous materials intermixed with organic matter allied to peat and lignite. The latter, which may be distinguished by the name of *Pyroschists*, yield little or nothing to benzole or bisulphide of carbon; but, when distilled at high temperatures, yield inflammable gases and an oil similar in character to petroleum. By the subterraneous distillation of these rocks petroleum may have been produced, but the shales first mentioned (those containing ready formed bitumen) have probably derived their bituminous constituents from petroleum.

The next theory to which I shall direct attention is that which supposes petroleum to have been produced from vegetable matter by a species of decay or fermentation—by a process indeed something similar to that by which coal is generally supposed to have been formed.

There can be no doubt that in the decay of vegetal matter certain volatile hydrocarbons are evolved, as for example marsh gas—the type of the hydrides I have

already mentioned as existing in so large proportion in petroleum. This gas is evolved largely from stagnant pools, marshes, and other damp places. It is this gas which gives rise to the well-known Will-o'-the-wisp or Jack-o'-lantern.

When wood is subjected to the action of air and moisture oxygen is absorbed from the air, and carbonic acid and water are evolved in the proportion of one equivalent of acid to two of water.

Now the composition of woody fibre may be set down as  $C_{24} H_{20} O_{10}$ ; therefore if in the process of decay sixteen equivalents of oxygen are absorbed, and eight equivalents of carbonic acid and sixteen equivalents of hydrogen are eliminated, there would be left a substance having the composition  $C_{24} H_4 O_4$ , and if the process is continued a residue of carbon only would be obtained.

When, however, woody fibre is so placed as to be excluded from the oxygen of the air, other reactions are conceivable. First, the whole of the oxygen of the wood may be given off in the form of carbonic acid ( $C O_2$ ), while the hydrogen remains with the residual carbon. The loss of ten equivalents of carbonic acid would, therefore, leave  $C_{14} H_{20}$ . But we know of no combination of carbon and hydrogen in which the number of equivalents of hydrogen exceeds by more than two those of carbon, the general formula of such a combination being that represented as  $C_n H_{n+2}$ , which I have already mentioned; therefore such a body as  $C_{14} H_{20}$  could not exist, but must break up into marsh gas, and a substance

containing less hydrogen. Supposing in this case four equivalents of marsh gas were formed, there would be left a body having the composition  $C_{10} H_{12}$ , which is in fact the composition of hydride of amyl, a body which exists in large proportion in petroleum.

Instead of combining exclusively with the carbon, a portion of the oxygen of the wood may combine with hydrogen, and be set free as water. For example: supposing four equivalents of carbonic acid and twelve equivalents of water to be eliminated from one equivalent of woody fibre, there would remain a hydrocarbon containing  $C_{10} H_{12}$ , which very closely resembles the composition of some of the solid bitumen.

The changes which take place in nature are, however, never so simple as what I have just described; the various modes of decomposition frequently go on together, or intervene at different stages in the decomposition of the same substance, according to the circumstances under which they are placed. It is impossible to say what are the precise conditions which favour the production of petroleum rather than coal; but we are acquainted with certain transformations which show us that under different conditions the same body may produce very different products. Take sugar, for example, which may yield either alcohol and carbonic acid, or butyric acid and carbonic acid with hydrogen, and even in certain modified fermentations acetic, lactic, and propionic acids, and the higher alcohols.

The following table (a portion of one given in a paper by Professor Sterry Hunt, which appeared in the *Chemical*

*News* of July 5th, 1862) shows the relation of different coals, petroleum, peat, &c., to woody fibre. I must state that the formula placed opposite each substance is not intended to represent its actual composition, but merely to point out its relation to the starting point in the series, and for this reason all the formulæ have been calculated with 24 equivalents of carbon.

Vegetable fibre	-	-	-	-	$C_{24} H_{20} O_{20}$
Brown Coal (Schrotter)	-	-	-	-	$C_{24} H_{14} O_{10}$
Lignite (Vaux)	-	-	-	-	$C_{24} H_{11} O_6$
Bituminous Coal	-	-	-	-	$C_{24} H_{10} O_3$
Ditto	-	-	-	-	$C_{24} H_{10} O_3$
Ditto	-	-	-	-	$C_{24} H_8 O_1$
Albert Coal	-	-	-	-	$C_{24} H_{16} O_4$
Asphalte	-	-	-	-	$C_{24} H_{14} O_3$
Bitumen of Idria	-	-	-	-	$C_{24} H_8$
Petroleum	-	-	-	-	$C_{24} H_{24}$

It is the opinion of many scientific men that petroleum may in some cases be of animal origin; and the fact of its being found in the lower palæozoic strata, which contain no traces of land plants, renders it very probable that it has been formed from marine plants and animals, and the latter is by no means unlikely, as the tissues of the lower marine animals are very similar in chemical composition to the woody fibre of plants. The decompositions which I have just alluded to may, therefore, take place in the same manner with such animal matter as it does with vegetable remains.

Other theories respecting the origin of petroleum have been propounded, but the two just alluded represent the

opinions of most scientific men who have examined the question.

There can be no doubt that petroleum has been derived from vegetable, and probably in many cases from animal, remains, But whether the process has been one of simple decomposition at ordinary temperature, or whether it has amounted to a process of distillation is at present doubtful. In my opinion the evidence which we at present possess on the subject appears to point to an extremely slow process of distillation of organic matter (animal or vegetable, and not necessarily first converted into the form of coal, &c.), effected at a much lower temperature than we are accustomed to use in preparing the ordinary coal oils.

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## CHAPTER IV.

### PROPERTIES AND COMPOSITION.

DIFFERENCE IN CHARACTER OF OIL FROM DIFFERENT LOCALITIES.—EXPLOSIVE PROPERTIES OF PETROLEUM.—POPULAR FALLACIES.—ODOUR OF PETROLEUM.—REMOVAL OF ODOUR.—PRODUCTS OF DISTILLATION.—COMPOSITION OF RANGOON OIL.—PETROLEUM OF SEBNE.—AMERICAN PETROLEUM.—RESULTS OF MR. SCHLORLEMER'S INVESTIGATIONS.—RESULTS OF INVESTIGATIONS BY MM. J. PELOUZE AND A. CAHOURS.—BENZOLE IN PETROLEUM.—OTHER ANALYSES OF PETROLEUM.

CRUDE petroleum obtained from different localities differs considerably in properties. Most of the oil is of a dark greenish or brownish colour, and cannot be used in lamps without undergoing the refining process; but that obtained from Smith's Ferry, Pennsylvania, is almost as clear and bright as the refined oil, and can be burnt in lamps as raised from the well. A mixture of half this oil and half ordinary crude oil very much resembles common whale oil, and burns well. Only a few barrels per day of this oil are obtained.

Much of the Persian oil is also colourless, and is consumed in lamps without rectification. Good Rangoon oil is nearly of the consistence of butter at ordinary temperatures. The African oil before mentioned is also considerably thicker than the American petroleum. There is a great difference in appearance, specific gravity, and odour between the Canadian petroleum and that obtained from the United States.

The specific gravity of petroleum varies considerably. Some obtained from wells in Venango County, Pennsylvania, has a density as low as  $\cdot 800$ , whilst in other regions the specific gravity of the oil reaches as high as  $\cdot 900$ . Much of the Canadian oil I have examined had a specific gravity varying from  $\cdot 820$  to  $\cdot 830$ , and occasionally as high as  $\cdot 850$ . As a rule the lighter the specific gravity of the oils the lighter their colour.

Much of the petroleum obtained from America evolves an inflammable gas or vapour at ordinary temperatures, and this vapour, when mixed with common air or oxygen, forms an explosive mixture, which takes fire when brought in contact with flame. Other samples do not evolve this vapour until the temperature is raised to  $80^{\circ}$ ,  $90^{\circ}$ , or even  $100^{\circ}$  F. The Rangoon petroleum does not evolve any vapour until heated to a much higher temperature; neither does the African petroleum.

There are many erroneous opinions prevailing respecting the properties of petroleum. For instance: some persons believe that it is liable to explode spontaneously, or that it explodes, like gunpowder, upon contact with a lighted match, candle, or simple spark. This is not the case. It is true that at common temperatures some samples ignite immediately upon the application of a flame, but the oil does not explode, but burns steadily. Many other samples may have a lighted match dipped into them repeatedly, and yet do not inflame until the temperature is raised to  $80^{\circ}$  or  $90^{\circ}$  F., that is, at the point at which they begin to evolve inflammable vapour.

The only way in which explosion can arise from petro-

leum is from the escape of inflammable gas or vapour, which vapour, as I have already stated, forms with atmospheric air or oxygen an explosive mixture. This mixture, however, does not explode unless brought in contact with flame. It has been stated that a single spark, falling from a candle or other light, is capable of igniting this mixture; but this is incorrect. It is not inflamed by a piece of iron heated nearly to whiteness.

It is hardly necessary to state—after the great outcry that has been raised against petroleum on account of its smell—that petroleum possesses an odour which is not pleasant.

The petroleum obtained from different localities differ considerably as regards smell. The Canadian oils, and those found in South America and the West Indies, are much more offensive than the oils of the United States. The disagreeable smell is chiefly owing to the presence of sulphur, and may also be due, to some extent, to the presence of small quantities of phosphorus and arsenic, both of which substances I have detected in the Canadian oil.

This smell can, however, be removed by treating the oil with various chemicals.

During the last few months much attention has been given to the deodorisation of petroleum, more especially with the view of destroying the offensive odour of the Canadian oil, and several patents have already been secured for the purpose.

It is a fact which does not admit of a doubt that much of the disagreeable odour of petroleum may be destroyed, and the oil rendered comparatively inodorous. Whether

this can be done at a sufficiently low rate remains to be proved. I believe that it can, and I am engaged at the present time in investigating a process by which the worst specimens of Canadian oil may be deodorised at a cost not exceeding one penny per gallon, and it is probable that by a little alteration this may be reduced to less than one farthing per gallon.

Upon distilling American petroleum a light spirit, possessing a specific gravity of .680, first passes over. This has been called "kerosolene." After the kerosolene has passed over a spirit somewhat heavier is obtained. This has been called "benzine;" but why it is so named I am at a loss to know, as it is certainly not the liquid known chemically by the name of benzine. Probably it is so called because it may be used as a good substitute for the real benzine for many purposes.

The kerosolene and "benzine" are frequently collected together, and sold under the names of "benzine," "petroleum spirit," or "turpentine substitute." There is also obtained by further distillation an illuminating oil, which has been called "photogen," "kerosene," and several other names. After the illuminating oil has been distilled, a heavy oil containing paraffin, and used for lubricating purposes, is obtained, and there remains a residue of pitch or coke.

The several products of petroleum will be described more at length after a description of the refining process has been given.

The temperature at which most specimens of American petroleum commence to boil is about 100° F.; and, as

distillation proceeds, the temperature gradually rises to as high as 600° F.

COMPOSITION.

The chemical constitution of petroleum has not yet been much studied. The composition of the various oils differs considerably, according to the locality in which they are found.

The Rangoon oil has been examined by Mr. Warren De la Rue and Dr. Hugo Muller (*Proceedings of the Royal Society*, Vol. VIII., page 221), and they describe it as a mixture of pure hydro-carbons, without any combination of oxygen, the greater portion of the oil being made up of hydro-carbons of the formula  $C_n H_n + 2$ ; but they did not succeed in isolating from these a compound of definite composition and boiling point. They also found small quantities of benzole, toluole, xymole, and cumole. The Rangoon oil likewise contains a large proportion of of paraffin, the average quantity being about 10 per cent.

M. Vohl has published an analysis of Rangoon oil. The density was 0.885, and by distillation and rectification there were obtained—

Illuminating oil, sp. gr. .830	-	-	-	40.705
Lubricating oil	-	-	-	40.999
Paraffin, fusing at 60° F.	-	-	-	6.071
Asphalte	-	-	-	4.605
Loss	-	-	-	7.620

---

100,000

Professor Vohl has put down amongst the loss carbolic acid and creosote; but in so doing he is probably wrong,

as these substances do not appear to be found in any mineral oil, although they have been frequently sought for.

The petroleum of Sehne, near Hanover, has lately been examined by Uellsman, and found by him to consist of hydro-carbons of the formula  $C_n H_n + 2$ ; but he failed to obtain compounds of constant composition and boiling point.

The mineral oils of America, like those already mentioned, are mixtures of various hydro-carbons, and do not contain any oxygen. From the results of experiments which have been made upon them they appear to be made up of hydro-carbons belonging to two or three series. The oils, as found in nature, contain as nearly as possible an equal number of equivalents of carbon and hydrogen; but the lighter portions contain an excess of hydrogen, and appear to consist principally of hydro-carbons of the formula  $C_n H_n + 2$ ; whilst the heavier products contain a larger number of equivalents of carbon than of hydrogen.

All the American petroleums contain paraffin, but not in so large a proportion as the Rangoon oil. A compound called *petrole* is also found in them, and it is owing to the presence of this substance that the peculiar odour of musk is produced when petroleum is treated with nitric acid, as this acid acts upon *petrole*, producing a musky odour.

Mr. Schlörlemmer, assistant in the laboratory of Owen's College, Manchester, has lately studied the composition of American petroleum; and, in a paper communicated to the Manchester Literary and Philosophical Society by Professor Roscoe, he states that he has found

in the oils known as "turpentine substitute" (the lighter portions of the crude oil) the following four compounds:—

$C_{10}H_{18}$  Hydride of amyl—boiling point  $34^{\circ}C$ .

$C_{12}H_{22}$  Hydride of hexyl— „ „  $68^{\circ}$

$C_{14}H_{26}$  Hydride of heptyl— „ „  $98^{\circ}$

$C_{16}H_{30}$  Hydride of octyl— „ „  $119^{\circ}$

In addition to these he obtained a small quantity of a liquid boiling between  $20^{\circ}$  and  $30^{\circ}C$ , and he infers from this that hydride of butyl is present in small quantities in petroleum. Four gallons of turpentine substitute, boiling between  $80^{\circ}$  and  $150^{\circ}C$ , yielded three pounds of pure hydride of heptyl. Mr. Schlorlemmer also found small quantities of benzole and toluole, and traces of olefines.

The composition of American petroleum has likewise been examined by MM. Pelouze and Aug. Cahours,\* and they have succeeded in isolating from the more volatile portion—that boiling under  $200^{\circ}C$ .—the following hydrocarbons, four of which have already been mentioned as obtained by Mr. Schlorlemmer:—

	Density.	Boiling Point.	Vapour Density.
Butyl hydride ..... $C_4H_{10}$	—	—	—
Amyl hydride ..... $C_5H_{12}$	0.628	$30^{\circ}C$	2.577
Caproyl hydride (hydride of hexyl) ..... $C_6H_{14}$	0.669	—	—
Ænanthyl hydride (hydride of heptyl) ... .. $C_7H_{16}$	0.699	$92^{\circ}$ to $94^{\circ}$	3.616
Capryl hydride (hydride of octyl) ..... $C_8H_{18}$	0.726	$116^{\circ}$ „ $118^{\circ}$	4.009
Pelargonyl hydride $C_9H_{20}$	0.741	$136^{\circ}$ „ $138^{\circ}$	4.541
Rutyl hydride ..... $C_{10}H_{22}$	0.757	$160^{\circ}$ „ $162^{\circ}$	5.040
— hydride ..... $C_{12}H_{26}$	0.766	$180^{\circ}$ „ $184^{\circ}$	5.458

\* *Comptes Rendus*, LVI., p. 505, also *Chemical News*, Vol. vii., p. 197.

The quantity of benzole in petroleum, *if any*, is exceedingly small. I have not been able to detect it in any specimen of the crude oil I have examined, although I have found it in several specimens of the "turpentine substitute," and I would suggest that the benzole in the latter was produced by decomposition during distillation.

This opinion is borne out by a remark made by Mr. Martin Murphy, of the Liverpool College of Chemistry, who stated, at a late meeting of the Liverpool Chemists' Association, that he had not found benzole in petroleum except in one or two cases in minute quantity, and then he believed it was produced by decomposition during his experiments.

The prospectus of the Canadian Oil Company mentions the production of the dyes mauve, magenta, &c., as one of the sources of profit from petroleum. At present this is out of the question, as the largest quantity of benzole found in petroleum, or rather in the turpentine substitute, is quite inadequate for the production of dyes on a large or remunerative scale.

The *Technologist* for March, 1861, contains an analysis of American petroleum by Mr. Dugald Campbell. The oil examined by this chemist was of a dark greenish colour, possessing a somewhat pleasant ethereal odour, and a density of  $\cdot 860$  at  $60^{\circ}$  F. It was distilled into four equal parts, and the specific gravity of each taken.

The first part had a density of - - -  $\cdot 825$ .

Second ,, ,, - - -  $\cdot 838$ .

Third ,, ,, - - -  $\cdot 833$ .

Fourth ,, ,, - - -  $\cdot 846$ .

Mr. Campbell remarks concerning this analysis:—  
 “The colour of these distillates varied. No. 1 was a light sherry colour; No. 2 was darker; No. 3 was still darker; and No. 4 brown. Their boiling points are high—No. 1 360° F.—and they do not, therefore, in this respect resemble naphtha.”

Another sample, of specific gravity ·900, was also tested by Mr. Campbell. “This was of a darker colour, and had not so much greenish tint about it. On standing it deposited a little water, and some yellowish earthy matter. The results from distilling were less favourable than from the first specimen.”

These two specimens of oil were evidently not equal to most of the petroleum imported into this country.

The following is an analysis of Canadian petroleum by Dr. Sheridan Muspratt. 100 parts of Enniskillen oil yielded in distillation:—

Light coloured naphtha, sp. gr. 0·794	-	20
Heavy yellow naphtha, sp. gr. 0·837	-	50
Lubricating oil, rich in paraffin	- - -	22
Tar	- - - - -	5
Charcoal	- - - - -	1
Loss	- - - - -	2
		<hr/>
		100

The next is an analysis of Barbadoes tar, made by Mr. Charles Humfrey, and published in the *Technologist* for March, 1863.

The sample was of a dark brown colour, very viscid, with faint pleasant smell. The specific gravity 0·940. 10 ounces gave—

Water	-	-	-	-	-	-	-	$\frac{1}{2}$ ounce.
Crude oil No. 1	sp. gr.	0·912	-	5	„			
„	No. 2	„	0·927	-	4	„		
Coke	-	-	-	-	-	-	-	$\frac{1}{2}$ „
								10 ounces.

No. 1, when refined, gave 4 ounces of fine oil of a pale colour, and very sweet; specific gravity 0·908. No. 2 gave  $2\frac{1}{2}$  ounces of fine oil of a dark colour, and some empyreumatic smell; specific gravity 0·918.

I have selected the following from a large number of analyses I have lately made, as showing the average composition of most of the petroleum imported into this country from Canada and the United States. These analyses were made for the purpose of ascertaining the quantities of the different products to be obtained from each. The specific gravity of the spirit and burning oil has been fixed at ·735 and ·820 respectively, as these densities are, in my opinion, the best points at which to fix the limits between spirit and burning oil, and between burning oil and lubricating oil.

	1 sp. gr. ·802	2 sp. gr. ·815	3 sp. gr. ·835	4 sp. gr. ·820
Spirits, sp. gr. ·735 .....	14·7	15·2	12·5	4·3
Lamp oil, sp. gr. ·820 ...	41·0	39·5	35·8	44·2
Lubricating oil.....	39·4	38·4	43·7	45·7
Paraffin .....	2·0	3 0	3·0	2·7
Coke.....	2·1	2·7	3·2	2·2
Loss.....	·8	1·2	1·8	·9
	100·0	100·0	100·0	100·0

No. 1. Pennsylvanian petroleum of a dark greenish colour, and strong but not unpleasant ethereal odour. Evolved an inflammable vapour at ordinary temperatures.

No. 2. Pennsylvanian petroleum of a dark greenish colour, with a somewhat unpleasant odour. Yielded an inflammable vapour at ordinary temperatures.

No. 3. Canadian petroleum of a dark brown colour, powerful garlicky odour. Evolved inflammable vapour at ordinary temperatures.

No. 4. Petroleum from United States, locality not known, of a dark greenish colour, faint and rather pleasant odour. Did not evolve inflammable vapour under 86° F.

Sample of African petroleum from a port on the Red Sea, imported by J. L. Caridias, Esq., of Liverpool, colour dark brown, faint and somewhat pleasant odour, specific gravity .912. Commenced to give off inflammable vapour at 180° F.

Oil suitable for illuminating purposes,

sp. gr. .835	-	-	-	-	-	-	30.0
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Heavier oil for lubricating purposes,

sp. gr. .887	-	-	-	-	-	-	59.5
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Paraffin	-	-	-	-	-	-	5.2
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Coke	-	-	-	-	-	-	3.7
------	---	---	---	---	---	---	-----

Loss	-	-	-	-	-	-	1.6
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100.0

## CHAPTER V.

### USES.

USES OF RANGOON OIL.—OF TRINIDAD ASPHALTUM.—PERSIAN ASPHALTE.—PETROLEUM AS FUEL.—FRENCH COMMISSION.—PETROLEUM GAS.—EXPERIMENTS AT HOMER AND COURTLAND.—MR. G. BOWER'S EXPERIMENTS, &C.

THE crude petroleums, as obtained from the wells, have been employed for various purposes without undergoing any refining process.

The very heavy oils are sometimes used for heavy machinery.

The Rangoon oil is largely used in India for lamps and torches; also for preserving wood, mat partitions, palm leaf, &c., from insects and the weather. The white ants will not attack wood which has been washed with it.

The Trinidad asphaltum, mixed with grease, is often applied to the sides of vessels to prevent the boring of the *teredo*. Mixed with quicklime it is said to form an excellent disinfectant.

It is said that wood steeped in petroleum is proof against decay for many years.

The asphalte obtained by the evaporation of petroleum is largely used in Persia and the neighbouring countries for covering the roofs of houses, and in France it has been employed for several years for making pavements.

Several of the oils are used in lamps just as they are obtained from the wells, without any refining process whatever.

Crude petroleum has also been used as a fuel, and has been applied for heating steam boilers. The French Government appointed a committee to examine the capabilities of petroleum for the generation of steam; and it has been proved that in seventeen minutes 4.25 lbs. of petroleum will raise steam to a given pressure that it requires 9.35 lbs. of the best coal to effect in thirty minutes. In sea-going steamers its adoption as fuel saves 250 per cent. in bulk; and where fifty men are to be employed for coal ten are sufficient with petroleum. The fire can be entirely extinguished in one minute and a-half, and ignited with a full blast in the same time. It can also be employed with the same advantages for locomotive engines. Mr. J. L. Linton is the inventor of the plan examined by the French commission.

I do not know what apparatus was employed in the above investigations, but the following is a description of an apparatus which has been employed for generating steam in boilers:—A series of iron pipes are laid in the fire arch of the boiler, which pipes are perforated in their upper surface with minute holes. The oil is supplied to these pipes by means of a force-pump, aided by an air-receiver to preserve a constant pressure. A spray, so to speak, of oil is thus made to fill the space usually filled by the flame of wood or coal, and this, once ignited, fills the fire arch and flues of the boiler, and maintains the desirable amount of heat in the boiler.

Several attempts have been made to employ petroleum instead of coal for the production of gas, and the results of some experiments at Homer and Courtland, in the State of New York, are most satisfactory, both with regard to the luminous qualities and the remarkable cheapness of the petroleum gas. (This cheapness refers to America, where the cost of the oil is very low.)

As the subject is one of very great importance, I have extracted the following particulars from a paper in the *Journal of the Board of Arts and Manufactures for Upper Canada*.

The process employed at Homer and Courtland is similar in most respects to that which enables the proprietor of the Stevenson House, St. Catherine's, C.W., to light his establishment with 180 burners, and at a cost of 86 cents a night, under what is known as Thompson's patent.

The retorts at Homer are two in number, and of the following dimensions:—

Length	-	-	-	-	-	-	-	7½ feet.
Breadth	-	-	-	-	-	-	-	16 inches.
Height	-	-	-	-	-	-	-	12 „

Two vertical tubes are cast on each retort for the purpose of supplying water and petroleum. The retorts are laid horizontally in an arch, exactly the same as ordinary coal gas retorts, for which they can be substituted without much trouble or expense. Each retort is divided into three chambers, called the petroleum, the water, and the coke chambers respectively.

Petroleum and water are introduced in continuous

streams through the tubes before described, so that, when once a barrel of petroleum is placed at a sufficient height to allow a pipe, provided with a stop-cock, to feed the retort, the fluid may be admitted, and the process of conversion into gas goes on without further trouble, until the barrel is exhausted.

Two series of experiments were recently made at Homer, with the following results:—

#### MEAN OF THE TWO EXPERIMENTS.

Total quantity of gas made, 5,280 cubic feet.

Total time occupied in making the gas, five hours thirty-five minutes, or very nearly 1,000 feet per hour, or 500 feet for each retort.

Petroleum consumed, eleven gallons per 1,000 feet.

In the first hour of the second experiment, the quantity made was 1,080 cubic feet; and the condenser showed that too much water was admitted (about one-eighth of the whole quantity of petroleum). This unnecessary quantity of water evidently cooled the retort, and prevented the gas from being formed so rapidly as during the first trial.

A one-foot burner, with this gas, gives as brilliant a light as a four-feet burner supplied with common coal gas.\* Hence, 1,000 feet of petroleum gas will go as far as 4,000 feet of ordinary coal gas for illuminating purposes.

In making coal gas a charge of 150 lbs. of coal is

\* A recent writer in the *American Gas Light Journal* states that petroleum gas gives a light six or seven times as luminous as coal gas. This may be the case; but, in order to avoid an error in excess, it is here placed at four times as great as ordinary coal gas: that is to say, a one-foot burner with petroleum gas is equal to a four-feet burner fed with common coal gas.

generally introduced into the retort, and allowed to remain for five hours. It generates 600 feet of gas, if the coal is of moderately good quality. This is at the rate of 8,000 feet for 2,000 lbs., or one ton of coal. To produce 600 feet of gas, the destructive distillation has to be carried on for a period of five hours. In a retort of the same dimensions, and heated in the same manner, no less than 2,500 cubic feet of petroleum gas are produced, under precisely similar conditions. But one cubic foot of petroleum gas is equal in illuminating power to four cubic feet of coal gas. Hence, in five hours the petroleum produces, when reduced to the equivalent of coal gas, the enormous quantity of 10,000 cubic feet of gas, against 600 by the coal process. The saving of fuel and labour is, consequently, enormous.

If we assume that the illuminating power of petroleum gas is only three times that of coal gas, the proportion of each kind produced in five hours is as follows:—

7,500 cubic feet of gas by the petroleum process.

600        „        „        by the coal process.

Hence, in this case, which is below the actual results, the gain in time required for the manufacture of petroleum gas, as compared with coal gas, is as twelve to one. This fact alone reduces the number of retorts in petroleum gas works on a large scale, to at least, say one-sixth of the number required for coal gas works. Actually, one petroleum retort can produce the equivalent in gas of twelve coal gas retorts. When the annual expense of retorts is taken into consideration, this item alone establishes a great argument in favour of the petroleum

process; for, not only is the number of retorts required diminished to the extent named, but all connecting pipes, huge hydraulic mains, and the extensive system of coolers and purifiers, are dispensed with in equal proportion. The labour of handling the coal is done away with, and a large proportion of capital in the construction of works saved.

To proceed now to the question of cost. Assuming that two benches, each containing two retorts, are used for making petroleum and coal gas respectively. The cost of apparatus in the first instance is about the same. The time for heating and the fuel consumed is the same. The cost of eleven gallons of petroleum (or 1,000 feet of petroleum gas) at six cents a gallon (the price in Toronto), is sixty-six cents. The cost of 250 lbs. of coal (or 1,000 feet of coal gas) at \$5 a ton, is 62½ cents. But 1,000 feet of petroleum gas is, at the lowest estimate, equal to 3,000 feet of coal gas. Hence the cost of 3,000 feet of coal gas (equal to 1,000 feet of petroleum gas), or 750 lbs. of coal, at \$5 a ton, is \$1 87½. Then there is the coke to be deducted from the price of the coal used in making 3,000 feet of gas, which may fairly be set against the smaller amount of labour required in handling the petroleum when compared with the handling of the coal.

Where petroleum is 10 cents a gallon, and coal \$6 a ton, the proportionate cost of the raw materials used will be as follows:—

Cost of 1,000 feet of petroleum gas	-	\$1 10
„ 3,000 feet of coal gas	- -	2 25

The foregoing comparisons refer to the original cost of

the material from which the gases are made; but, if we take the price actually charged by gas companies into consideration, the results are the more striking.

The cost of private works to supply 200 burners will be about \$1,000; the labour of one man per diem; lime for purifying; three bushels of coke at 10 cents a bushel; so that the entire cost will be—

Interest on capital at 8 per cent. per annum - - - - -	\$80 00
Labour at \$1 per day - - - - -	365 00
Lime for purifying, 200 bushels per annum, at 20 cents a bushel - - -	40 00
Petroleum to produce gas for 200 one-foot burners, five hours a day throughout the year (365,000 feet of gas), 4015 gallons, at 6 cents a gallon - - - - -	240 90
Fuel, say four bushels of coke a day at 10 cents a bushel - - - - -	146 00
<hr/>	
Total cost - - -	\$871 90

The equivalent of 365,000 cubic feet of petroleum gas in coal gas is 1,095,000, reckoning one foot of petroleum gas equal to three feet only of coal gas.

Cost of 1,095,000 cubic feet of coal gas,  
at \$2 50 per 1000 feet (a low price  
in the United States and Canada) \$2737 50

Difference per annum in favour of  
petroleum gas - - - - - 1865 60

If the price of petroleum is 10 cents a gallon, instead

of 6 cents, the difference in favour of the gas will be, per annum, \$1705. Thus:—

Interest on capital	-	-	-	-	\$80 00
Labour	-	-	-	-	365 00
Lime	-	-	-	-	40 00
Petroleum	-	-	-	-	401 50
Coke	-	-	-	-	146 00

---

\$1032 50

1,095,000 cubic feet of coal gas, at

\$2 50 per 1,000 - - - 2737 50

Difference in favour of petroleum gas,

per annum - - - -\$1705 00

In works where twelve coal gas retorts are in operation day and night, each being charged with 150 lbs. of coal, they can produce 36,000 cubic feet of gas in twenty-four hours. This quantity can be yielded by two petroleum retorts in twelve hours. Thus:—

Two petroleum retorts yield 1,000 cubic feet per hour.

In twelve hours the yield will be 12,000 feet.

The equivalent of 12,000 feet of petroleum gas is equal to 36,000 feet of coal gas.

If reduced to the same unit of time, namely, twenty-four hours, two petroleum retorts, of the same dimensions as coal gas retorts, will yield 24,000 cubic feet of petroleum gas, the equivalent of 72,000 feet of coal gas, or as much as twenty-four ordinary coal retorts charged with 150 lbs. of coal each, every five hours, can produce in twenty-four hours.

There are other facts which make the production of

gas from petroleum more economical than from coal. The quantity of lime required for purifying is not so great by one-half. The amount of water needed for cooling and washing is very considerably less, and the tar produced is small in quantity when the yield of gas is taken into account. The gas is free from those noxious sulphurous compounds which render badly purified coal gas so disagreeable and prejudicial.

The destruction of retorts in the manufacture of coal gas is immense. This arises, in a great measure, from the formation of graphite in the inside of the retorts, which accumulates in concentric layers, and sometimes forms a coating one or two inches thick. The retorts also suffer to a great extent by the entrance of air when introducing the charge of coal. This source of rapid destruction is avoided altogether in the petroleum retorts, which do not communicate with the atmosphere when in a heated state, and only require to be occasionally opened to remove the deposited carbon or graphite, which, by the way, can very conveniently be removed by partially filling the petroleum chamber with fire brick, whereby the heated surface to which the rich hydrocarbon vapours are exposed is greatly increased, and their conversion into permanent illuminating gases much facilitated. The deposition of carbon is materially diminished by reducing the pressure of the gas on the retort, and this, by a simple adjustment of the water-joints in the petroleum apparatus, may be reduced to a minimum.

The use of water in the process by which the result described previously is produced, is for the purpose of

converting the volatile hydrocarbon vapours of petroleum into permanent gases. It is thrown into its spheroidal condition the moment it strikes the interior of the retort, and in this state its spheroids continually develop steam of very high temperature and great reducing power. The rich petroleum gas may be largely diluted by the formation of the so-called water gas; but this has been shown to be an expensive process, and it is far more economical to employ a one-foot burner with a highly luminous gas than a three or four-foot burner with a diluted gas.

The advantages possessed by petroleum gas as a cheap illuminator have already been sufficiently established; but its claim to public patronage does not rest on this fact alone. It is a most economical and valuable source of heat. Coal gas stoves have long been in limited use; but they have not met with general favour, because they do not supply a sufficient amount of heat, and they are, besides, too costly when the coal gas is maintained at \$2 50 per thousand feet. Petroleum gas is admirably adapted as a source of heat. It contains a much larger proportion of carbonetted hydrogen than coal gas; but carbonetted hydrogen generates more heat during combustion than either the same measure of hydrogen or carbonic oxide, as the following table, deduced from Dulong's experiments, proves:—One cubic foot of carbonetted hydrogen, during its combustion, causes a rise of temperature from 60° to 80° in a room containing 2,500 cubic feet of air; whereas a cubic foot of carbonic oxide elevates the temperature of a room of 2,500 cubic

feet from  $60^{\circ}$  to  $66^{\circ}6$ , and one cubic foot of hydrogen raises the temperature of a room of the same cubical capacity as before stated from  $60^{\circ}$  to  $66^{\circ}4$ . Or, in other words, a cubic foot of carbonetted hydrogen is capable of heating 5 lbs. 14 ozs. water from  $32^{\circ}$  to  $212^{\circ}$ , a cubic foot of carbonic oxide 1 lb. 14 ozs. through the same degrees of temperature, and a cubic foot of hydrogen 1 lb. 13 ozs. of water from  $32^{\circ}$  to  $212^{\circ}$ . With a burner and apparatus of peculiar construction, and consuming six feet per hour, a petroleum gas flame, from eighteen inches to two feet in length, can be produced under the same pressure as is used for lighting purposes. The flame is almost destitute of luminous qualities, but the heat it emits is intense. It can be used for heating private dwellings, for cooking, and other domestic purposes. The cost of this gas fuel is, at the rate of one stove burning for thirty days, ten hours a day, \$1 30, when petroleum is 6c. a gallon; when it is 10c. the cost per month is \$2. For \$2 a month the house of a poor man may be supplied with light and fuel during ten hours of the day. With a burner of less dimensions—say three feet per hour—a cooking stove and one-foot burner, supplying abundance of warmth and light for one room during twenty-fours each day, may be fed at a cost of \$2 a month. This, of course, is the price of the raw material alone. \*

\* The observations on the use of petroleum gas as a source of heat for cooking, &c., are here given as they occur in the paper before alluded to, but I would remark that although petroleum gas is decidedly superior to coal-gas in illuminating power, I do not consider it so well suited for heating or cooking purposes. See also remarks of Mr. Bower, at page 62.—A. N. T.

It must be remembered that the foregoing observations on petroleum gas refer only to America, where coal gas is much more expensive, and petroleum much cheaper, than in this country. Still, however, even here it may be found advantageous to make use of petroleum as a gas-producing material for some purposes. For instance, where a very pure and bright light is required, and where the difference in cost is not of very much moment, petroleum gas would no doubt be decidedly preferable to coal gas. For use in picture galleries petroleum gas would most certainly be better than coal gas, as it does not contain the sulphur compounds, &c., which are found in coal gas, and which most undoubtedly damage oil paintings to some extent. Possibly it may be found advantageous to mix petroleum gas with ordinary coal gas to increase its illuminating power.

Mr. George Bower, gas engineer, of St. Neots, Huntingdonshire, has kindly placed at my disposal the results of some experiments made by him to ascertain the gas-yielding properties of petroleum, and also to see whether it can be used along with common coal, wood, or peat for the purpose of enriching the gases made from these substances, so as to compete with boghead, which is the material now generally used.

The apparatus employed by Mr. Bower consists of a double acting retort, four feet long, and known as the Fitzmaurice retort, of which Mr. Bower is the proprietor.

*Fig. 3* shows a longitudinal section of this retort.

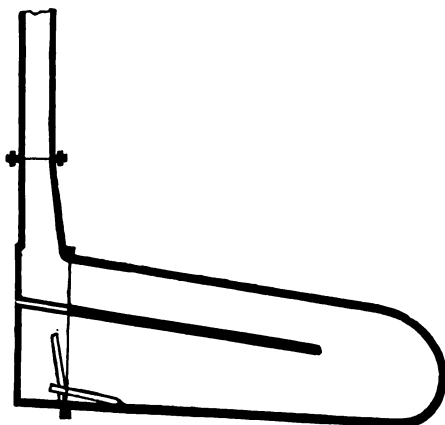


FIG. 3.

*Fig. 4* shows the front elevation of the retort.

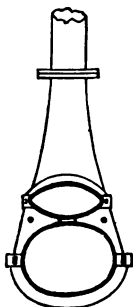


FIG. 4.

The rest of the apparatus is the same as for ordinary coal, excepting that no purifier is required; but the condenser has double the surface of that for coal, on account of the rapidity with which the gas is evolved. A meter to measure the quantity of gas produced, and a gasholder, complete the apparatus.

The oil employed was supplied by Mr. Alex. S. Macrae, of Liverpool, and there were two qualities, one of specific gravity  $\cdot 805$ , and the other  $\cdot 910$ , water being 1; but the following remarks refer to that of sp. gr.  $\cdot 805$ , as it was found on the whole to be more economical to use than the other. The lighter the oil the better the yield of gas, and the heavier

it is the greater the heat required to get the best results.

It has been a common practice in making gas from oil to fill retorts with coke, broken bricks, or any material which will give surface, and the oil has been dropped or run into them, or made to traverse through them; but this appears to be a very effective way of absorbing the carbon to which all gas owes its luminiferous property. From the result of a great number of experiments, Mr. Bower concludes that a high heat with a large surface is the very worst plan which can be adopted for making gas from oil; but that in order to get the best results, a moderate heat, dull cherry red by day-light, and the double form of retort without anything in it, give the best results, not for volume of gas, but for *quantity of light*; in other words, there is more light from 80 cubic feet of gas produced in accordance with the latter plan from the gallon of oil, than from 160 feet produced according to the former mode from the same quantity of oil.

Respecting the cost of gas from petroleum, Mr. Bower remarks:—"With the present prices of oil (about 1s. per gallon) the gas cannot be other than very costly, when compared by volume alone against ordinary coal gas; but when all collateral advantages are taken into consideration, and a comparison instituted upon the basis of quantity of light from equal volumes, then the contrast is not so marked.

The advantages which oil gas has over coal are in the fact that it requires no purification, being absolutely free from impurities. Hence, it may be used in the most

sumptuously decorated saloon, library, or picture gallery without the slightest fear of its injuring anything whatever. The process of making the gas is much more simple, the apparatus to produce an equal quantity of light as from that of coal is much less costly, and consequently the wear and tear is also less, and not only is a less quantity required for an equal amount of light, but the heat is considerably less than from coal gas.

If the comparison be made as between *coal* and *oil*, coal undoubtedly makes the cheaper light by far ; but, if it be instituted as between tallow and oil, as ordinarily burnt in lamps, then the cost of light from petroleum oil gas is very much less than from either of them.

One ton of oil will produce as much gas as will give the light of that produced from four tons of good Newcastle coal. Thus where carriage forms the chief item of cost of the material at its destination, oil may, in such a case, enter into favourable competition with coal ; or, where the first consideration is *purity*, and to have a gas, which, light for light, shall be more brilliant and powerful than the oil burnt in the solar and moderate lamps, then not only is petroleum superior, but is also of considerably less cost.

One foot of oil gas will give the light of three feet of ordinary coal gas, and, though gas, under very high pressure, loses some of its luminous qualities, yet it may be condensed at fifteen atmospheres, and thus become perfectly portable ; so that, beginning with a gas of three or four times the illuminating power of common coal gas, and condensing a given volume into a fifteenth

of its bulk, there is in this fact alone a large field for the use of oil gas for the lighting of railway trains, ships, private carriages, and country houses, where it may not be feasible or policy to erect small gas works for the supply of gas at ordinary pressures. For instance, a vase of a capacity equal to half a cubic foot, if charged with oil gas, compressed to fifteen atmospheres, will deliver seven feet, and as this is, to begin with, three times more powerful than common gas, its effect will be equal to six or eight candles for seven hours.\*

The daily cost of petroleum oil gas, when made to supply one hundred lights burning for six hours, with each light being equal to eight candles, is as follows :—

	£	s.	d.
Fifteen gallons of oil, 1s. - - -	0	15	0
Coke to heat the retorts, three cwt., 1s.	0	3	0
Labour—part of a lad or man's time	0	1	6
Wear and tear - - -	0	0	9
Interest on capital - - -	0	0	4
Fund to maintain plant in perpetuity	0	0	6

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Net cost of 1,200 cubic feet - £1 1 1

This is about five times what coal gas would cost made on the same scale; but as the illuminating qualities of the 1,200 cubic feet are equal to about 4,000 of ordinary coal gas, the oil does not compare very unfavourably when everything is taken into consideration, so that if the gas

\* His Royal Highness, the late Prince Consort, took great interest in portable gas, and the vase alluded to above is one made specially for his own use to contain compressed oil gas. This vase is now in Mr. Bower's possession.

be required only for lighting purposes, and not for cooking or heating (for which it is totally inapplicable), then there are very many who will doubtless prefer paying a high price for oil gas, in order to get a light which is *absolutely pure*, and which, though not nearly so cheap as ordinary coal gas, is nevertheless infinitely cheaper than oil, tallow, or wax, as ordinarily burnt, and without their inconveniences."

It will be seen that the results of Mr. Bower's experiments already given refer only to the use of petroleum, unmixed with other materials, for gas making; but the following remarks refer to his experiments on the use of petroleum for enriching the gas produced from wood and peat: the latter substances being at present exclusively used in many parts of Russia, Sweden, and Germany for the production of illuminating gas.

The gas made both from wood and peat has much less illuminating power than coal gas, and contains a very much larger proportion of carbonic acid, especially that made from wood, which must be removed or there is scarcely any light at all from the gas. But by using petroleum in conjunction with wood or peat, a gas of excellent quality is produced at a comparatively cheap rate, as the oil gives what the wood and peat gas is deficient in.

Mr. Bower's experiments with both wood and peat gave the same results as nearly as possible, so that what follows may be considered as equally applicable to both.

The following are his own remarks on the subject:—  
"Pitch pine, birch, and birch bark are used in Sweden and

Russia, peat in Bavaria and Bohemia, and perhaps in some parts of Ireland; and there is no reason why peat should not now, in conjunction with petroleum, be very extensively used in the latter country, both for private mansions and for lighting small towns. I take the whole of the wood and peat in its thoroughly dried state, when delivered at the gas works, in each country at 20s. per ton, though in most parts of Sweden and Russia a sajene of wood (a cube of seven feet) may be bought for less than a pound sterling, and its weight would vary from 25 to 30 cwt., so that whether for wood or peat this price is a fair average. The cost, then, of making commercially 5,000 cubic feet of gas per day, with wood or peat at 20s. per ton, and petroleum at one shilling per gallon, is as follows:—

	£	s.	d.
Twelve gallons of oil at 1s. -	0	12	0
1,120 lbs. of wood or peat at 20s. per ton	0	10	0
Wood for heating two retorts set over one furnace, 560lbs. -	0	5	0
Lime, for purification, 4 bushels -	0	3	0
Labour, one man's time chiefly taken up but calculated as wholly so, at per day -	0	2	6
Wear and tear, at the rate of 4s. per ton of wood or peat distilled -	0	2	0
Interest of capital on works, which with buildings would cost about £450, at 5 per cent. per annum -	0	1	3
Carried forward.....	£1	15	9

	£	s.	d.
Brought forward.....	1	15	9
Renewal of plant and buildings -	-	0	1 0
	<hr/>		
	£1	16	9
Deduct 448lbs. of charcoal			
at 30s. per ton      -      -	0	6	0
Oil and wood tar      -      -	0	0	9
	<hr/>		
		6	6 9
	<hr/>		
Net cost of 5,000 cubic feet -	£1	10	0

of gas the quality of which is equal to that from Wigan or Newcastle cannel, or about one-and-a-half times greater than that from ordinary coal, being equal to about 4s. per 1,000 cubic feet for common twelve-candle gas; and though it may contain a small quantity of carbonic acid gas, yet it is perfectly free from sulphur compounds.

I anticipate for this oil a very great application, more for enriching gases deficient in carbon, such as those producible from wood and peat in countries where they only can be had at anything like reasonable prices, than for being used alone for gas-making, as, in addition to the great cost of oil gas, it is extremely difficult to burn it properly without being much diluted with hydrogen; as no matter how attenuated the flame may be without such dilution, ordinary air will not suffice to produce perfect combustion; hence, smoke which is highly objectionable, is frequently the result."

The experiments above detailed are extremely valuable and interesting, and especially so from the fact of their being of so practical a character, and from their having

been made by a gentleman whose experience in gas-making from various materials is very extensive.

Judging from the results obtained there cannot be a doubt that petroleum gas may be employed in many cases with decided advantage, and it will probably become used to some extent, although at present its price is a great drawback.

Before leaving this part of the subject I wish to point out to refiners the desirability of collecting the gas which is evolved during the refining of petroleum. Large quantities of gas are given off, and if collected it may be used advantageously for lighting purposes. Some manufacturers have already adopted this plan, and I have seen a small apparatus for the purpose at the works of Messrs. Prentiss and Co., at Birkenhead. Mr. Prentiss informs me that it effects a considerable saving—a point which all manufacturers should look well to.

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## CHAPTER VI.

### REFINING.

GENERAL METHOD OF REFINING.—APPARATUS, STILL, CONDENSERS, WASHERS.—MR. GOULDIE'S WASHER.—PRENTISS'S PROCESS AND APPARATUS.—PRICE'S PATENT CANDLE COMPANY'S PROCESS.

THERE are several methods employed in refining petroleum, and, owing to the difference in character of the crude oils, it is an exceedingly difficult matter to prescribe a general mode of treatment which will answer in all cases.

The following is a description of the process most commonly adopted, and it will be seen that it is very similar to the process employed in refining the oils obtained by the distillation of coal.

It should be stated, however, that with many oils it is unnecessary to subject them to the whole of the following treatment, as they may be rendered sufficiently pure by only partial treatment.

The apparatus employed is a common iron still (*fig 5.*) protected by brickwork, which prevents the fire from playing directly on the still, and serves to equalize the temperature and lessen the risk of fracture of the still.

*a* is a cast-iron still, to which is fitted the cover *b*, connected with the neck *c*; *d* is a man-hole used for

cleaning the still and other purposes; *e* is a pipe accurately fitted to the still, and used for running off the contents of the still when necessary. It is but seldom that this pipe is fitted to the still, most of the

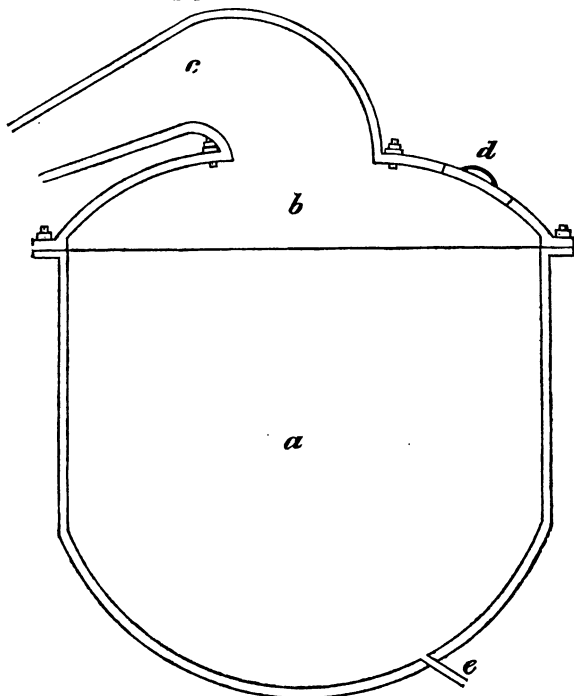


FIG. 5.

ordinary stills being without it. Steam pipes are inserted into the still when steam is used in the distillation process.

Connected with the still is a coil of iron pipes placed in a large vat or trough, and surrounded by water. The

iron pipes are generally arranged in the form of the ordinary condensing worm used in the distillation of water, spirits, &c. These worms or condensing pipes should be—for ordinary sized stills—100 feet in length, with a diameter of not less than six inches where they leave the neck of the still, four inches throughout the middle part, and tapering gradually towards the end, so that the “tail pipe” or exit is two inches in diameter. The water which surrounds the pipes is kept quite cold until paraffin begins to pass over, and then it must be kept at a temperature not under 80° F., or there is danger of the paraffin becoming solid in the worm, thereby filling it up and probably causing the bursting of the still.

Occasionally the condenser is formed of a series of iron pipes laid horizontally, and connected together at the ends.

The charge of crude oil is run into the still, and distilled without steam until the residue in the retort is of the consistence of a thick pitch when cold. If it is intended to obtain this pitch as one of the products, which is frequently the case, the distillation is stopped at this point; but it may be carried further by passing steam into the neck or breast of the retort, which produces an outward current through the condenser, and carries over all the remaining portion of the oil, leaving a compact coke. The steam also gradually reduces the temperature of the still and lessens the chances of fracture. As soon as the steam is let in, the fire is withdrawn. Common steam under moderate pressure has been used by introducing it into the still, both above and

into the charge throughout the entire distillation. When injected into the charge, the steam soon becomes superheated after the lighter oils have passed off. Steam previously superheated has also been employed by introducing it into the charge during distillation, and for the distillation of the heavy oils this plan has been found to have a decided advantage; indeed steam, in whatever way it is applied, is undoubtedly advantageous. When superheated steam is employed, the condensing apparatus should be very extensive.

In some works it is the practice to warm the charges before introducing them into the stills, and this may be done advantageously by economising the waste heat from the still fires. A continuous stream of fresh oil may also be run into the still so that the operation may go on without interruption, except when it is necessary to clean the still. The stream should equal but not exceed that passing from the condensers. The pipe which conveys the oil into the still is made to dip below the surface of the contents of the still. By this method a still will work at least double the quantity that it can by the ordinary mode of working.

The oil which distils over is collected in two portions, which require different treatment. (I will distinguish these two portions as A and B.) The first portion A, contains all that passes over of a specific gravity not exceeding  $\cdot 828$  or  $\cdot 830$ , whilst the second, B, consists of the heavier hydrocarbons.

The quantity of residue or coke left varies, sometimes as much as ten per cent. or even fifteen per cent. is left;

but, when proper care is employed, not more than five per cent. is found, and in some cases as little as three per cent. only is left.

The first portion of the distillate A is placed in a cistern, and agitated for one or two hours with from four to ten per cent. of sulphuric acid. The quantity varies according to the quality of the oil; if too much acid is employed the oils become partially charred and discoloured, and if too little is used impurities remain, and the oils are apt to change colour.

After the mixture of oil and acid has been thoroughly well agitated, it is allowed to rest for six or eight hours; the acid and impurities settle to the bottom, and are drawn off, and the oil agitated with water to remove the soluble impurities and any acid that may remain.

Another settling then takes place, and the water, when it has separated from the oil, is drawn off. After this again the oil is agitated for two hours, with from five to ten per cent. of a solution of caustic soda of specific gravity 1.40, in order to remove all traces of acid and the remaining impurities.

The strength of both the acid and the alkali varies according to the quality of the oil acted upon.

The mixture is now left to repose for six hours, the alkali is then drawn off, and the oil once more washed with water.

During the whole of the operations just described the temperature of the oil must be kept at about 90° F.—not under. This is done by means of steam coils placed at the bottom of the agitating vessel.

And here it will be as well to describe the vessels used for agitating the oil with acid, alkali, &c.

*Fig. 6* is a section of a vertical washer, and is one

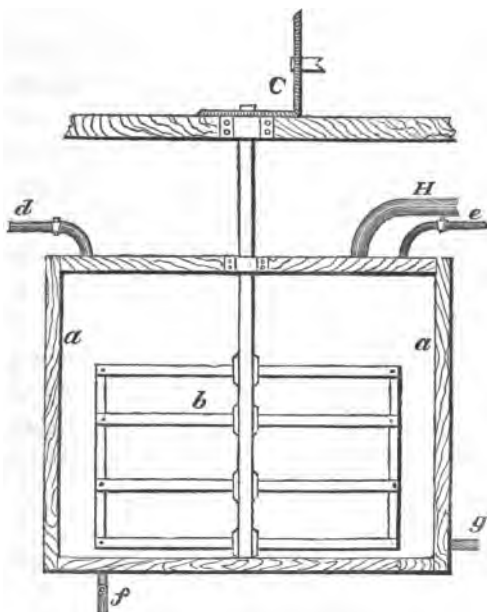


FIG. 6.

which is very much used by refiners.

*Fig. 7* is an end section, and *fig. 8* a longitudinal section of the horizontal washer, which for some reasons is preferred by many manufacturers. The following description will answer for both washers:—

*a* is a vessel made generally of wood and lined with lead, but sometimes it is of iron; *b* is an agitator (the sketches represent the most simple forms, but the shape

differs in nearly every refinery): the agitator is worked by the machinery *c*. *d* is a pipe by which the oil is run

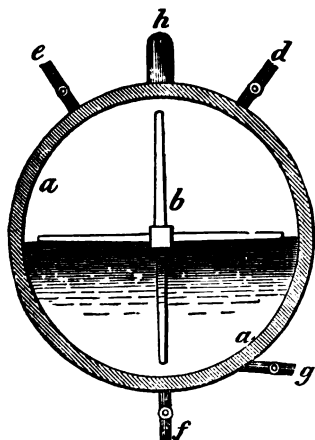


FIG. 7.

oil has been invented by Mr. Gouldie, of the Albion Oil

into the washer; *e* is another tap for running in water; *f* a tap for running off the oil, &c., after washing; and *g* is a steam tap connected with a coil of pipes in the washer (these pipes are not shown in the sketches); *h* is a pipe for conveying away the gas which is evolved.

A very ingenious contrivance for washing the

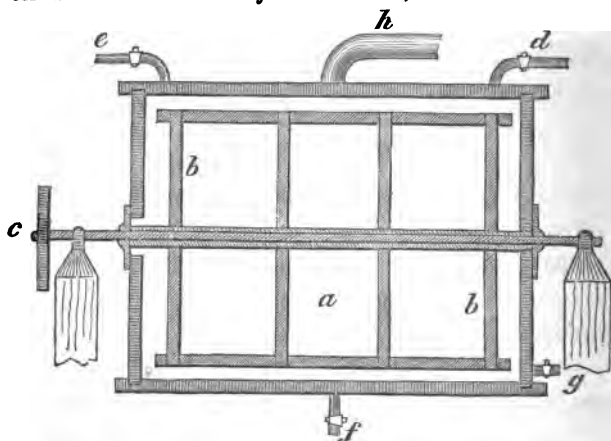


FIG. 8.

Works, Birkenhead. It consists of a vessel (*fig. 9*) divided into two compartments by means of a partition *e* down the centre; this partition, however, does not quite reach to the bottom. Sulphuric acid is first run into and occupies the bottom of the vessel up to the point indicated by the dotted line *a*. The oil is now run into the

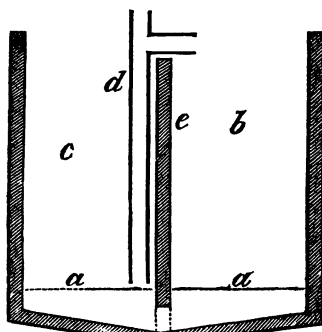


FIG. 9.

compartment *b*, and as soon as there is a sufficient weight of oil in, it is forced through the acid, and rises into the other compartment *c*, from which it is pumped back again into the first compartment by means of the pump *d*, and the process goes on in this way until the oil has been sufficiently treated.

Some refiners prefer not to agitate the oil with solution of soda in the washers, but merely place it with the soda solution in a tank, and agitate it by hand by means of a rake or plunger. This is decidedly the best plan, as by agitating it in the washers by machinery, the alkaline solution is so intimately mixed with the oil as to convert it into a soapy, or rather jelly-like, substance, and thus entirely spoils the product. By agitating for a short time by manual labour this does not take place; but yet the agitation is sufficient for removing all traces of acid and other impurities.

After being subjected to the washings with the acid, alkali, &c., as just described, the oil is finally well washed with water, and afterwards run into a still for rectification. It is then distilled with great care, all fluctuations of temperature being avoided as much as possible. The first portion which comes over is frequently discoloured, and is returned to the still.

The oil or spirit which passes over until the distillate has a specific gravity not exceeding  $\cdot 735$ , is collected separately, and forms what is known as "*petroleum spirit*," "*turpentine substitute*," &c.\* It is sometimes, but very seldom, mixed with the lamp oils. This is a practice which cannot be too strongly condemned, as will be seen further on.

The next portions of the distillate not exceeding specific gravity  $\cdot 819$  or  $\cdot 820$  form the lamp oil; and all the heavier portion is transferred to the next charge, or to the lubricating oil.

The second portion of the first distillate from the crude oil—that which I have called B—is treated in the same manner as the first portion, with the exception that the strength and quantity of both acid and alkali are greater.

In the rectification, all that passes over of specific gravity not exceeding  $\cdot 819$  or  $\cdot 820$  is added to the lamp oil, whilst the remainder forms the lubricating oil.

The lubricating oil is afterwards subjected to a further treatment—which I shall mention presently—in order to separate the paraffin it contains.

\* When kerosolene is prepared, this proceeding is slightly modified. See page 81.

The process of refining which has just been described is the one most usually adopted. There are, however, in some works modifications of this process employed. For instance, it is occasionally the practice, especially with the better class of crude oils, merely to subject them to one distillation, each product being collected separately. The washings with acid, &c., in this case, are also often dispensed with.

It is likewise the practice of some refiners to separate first of all the spirit or lighter portion of the oil by distillation with steam, and this is also effected in a separate still set apart for the purpose. The spirit is then treated either with acid or alkali, or with both, according to its quality, in the manner which has been already described. The remaining portion of the oil is then treated by the process described in the foregoing pages. It is decidedly advantageous to separate the spirit in this manner.

The specific gravity of the different products obtained by different manufacturers varies to a considerable extent. For example, one maker will not allow the specific gravity of the lamp oil to exceed  $\cdot 800$ , whilst others run it to  $\cdot 810$ , or even to  $\cdot 820$ , or higher. Some refiners also prefer not to use sulphuric acid in the refining process, but employ only alkalies and careful washing.

Steam is likewise used at various degrees of heat.

Several patents have lately been taken out for apparatus, and sundry improvements for refining petroleum. The most important of these are certain apparatus designed and patented by Messrs. E. F. Prentiss and Co., of Birkenhead.

The following is a description of Prentiss's continuous still :—

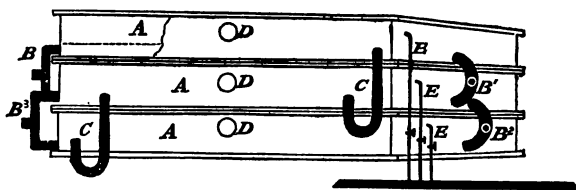


FIG. 10.

A A A are three stills placed one above another. Each still consists of a steam chest and a chamber for containing the oil to be distilled. The division between the steam chest and the oil chamber may be seen in the top still.

B B¹ B² B³ show the position of the steam-cocks and pipes by means of which steam is introduced into the still.

C C are syphon pipes for conveying oil from the upper to the lower still.

D D D are pipes for the escape of vapour.

E E E are pipes for carrying away the water which condenses in the steam chambers.

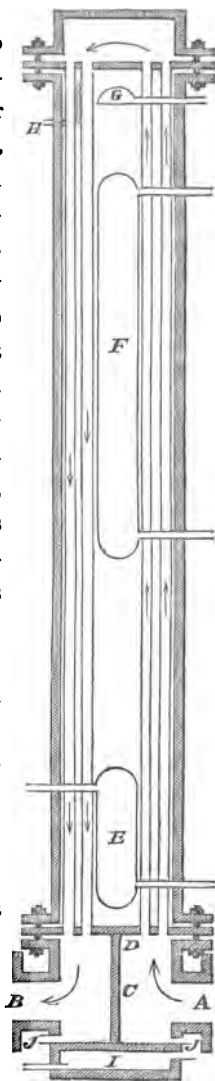
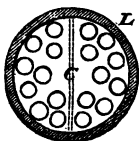
The three stills shown above are kept at different temperatures. The first is kept at a temperature sufficiently high to drive off the spirit; the second is kept at a temperature high enough to distil the burning oil; and the third is kept at a temperature sufficient to distil all the heavier portion of the oil.

In the highest still all the oil which is not converted into vapour by the temperature at which the still is kept, passes by means of the syphon tube C into the still

next below it, and there, owing to the temperature being higher, a portion of it is converted into vapour and distils over. There is, however, some of the oil yet remaining, and this requires a still higher temperature for its distillation. It is therefore conveyed by the syphon C<sup>1</sup> into the lowest still, and is there distilled. It must be stated that only a thin layer of oil is kept in each still, so that evaporation proceeds very rapidly.\* Connected with the still is a condensing apparatus, also the invention of Messrs. Prentiss and Co. It is so arranged as to collect separately the different products of the distillation.

A is the entrance from the still, the arrows showing the course taken by the vapours until their exit at B, from whence they proceed to the next column. The bottom of the column is divided by a cast-iron partition C, made tight to the plate

\* Since this still commenced working it has been found necessary to make some slight alterations in its construction, and, instead of using steam, hot air is, I believe, employed.—A.N.T.



D which supports the tubes. The position of the tubes is shown in the section L.

E is a copper-case for the application of steam, to heat the contents of the column.

F is a copper vessel to contain the air, the action of which regulates the heat of the column.

G shows an arrangement for admitting cold liquor, to cool the contents of the column, when required.

H is an overflow.

I is a steam chamber for keeping that part of the column warm.

J J are exit pipes for condensed liquors.

Three or four such columns are connected with each still, each column being kept at a different temperature to the others, the heat being so arranged that each product may be condensed and collected separately in the column set apart for the purpose. This may, perhaps, be better explained by saying that the column nearest the still is kept at a temperature sufficiently high not to allow the burning oil and spirit to condense in it, yet at the same time it is low enough to cause the lubricating oil to condense. The burning oil and spirit (in a state of vapour) pass on to the next column, where the burning oil is collected; the spirit then proceeds to the third column and is there condensed.

The advantages of this method of distillation over the ordinary methods are the collection of each product separately, without proceeding to a second distillation; also, the conversion of the oil into vapour takes place much more rapidly when exposed in thin films to the

action of heat in this still than it does in an ordinary retort.

Another still has likewise been patented by the same firm.

A is a globe seven feet in diameter, the walls of which are of cast-iron, one inch in thickness. It is surrounded by a wrought-iron steam-tight jacket three-eighths of an

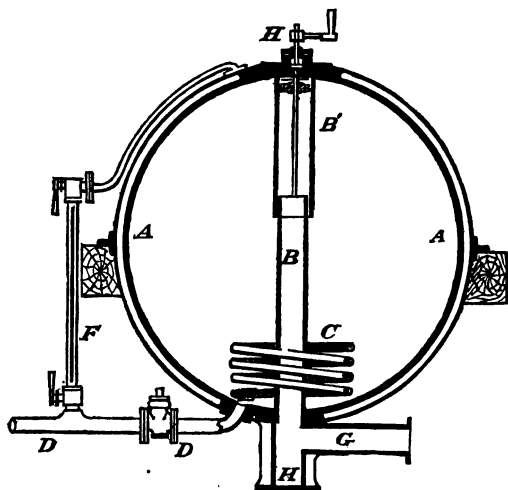


FIG. 12, PRENTISS'S GLOBULAR STILL.

inch thick, and fixed three inches from the outside of the still. B is a tubular pillar rising to the height of two-thirds the diameter of the still from the bottom, to which it is fitted steam-tight by accurate grinding; the outside of this pillar is turned perfectly true, so as to enable another tube B<sup>1</sup> to slide up and down upon it in the manner of a telescope, it being worked by the screw H shown in the manhole lid. The object of this is to

prevent the liquid from boiling over into B, as by lowering or raising B<sup>1</sup> the vapour can be taken off from as near the surface of the liquid as may be desired, or found safe. There is an opening into the still, not shown in the sketch, for admitting steam when required into the coil C. The pipe D, connected with the opening E, is employed for discharging or filling the still. Inserted into this pipe is a glass guage F for showing the quantity of oil in the still. G is a continuation of B, and carries the vapours to the condensers. At the bottom of the tube B is a small chamber H, with a separate outlet (not shown) for catching any little portions of the crude contents of the still that may accidentally get into B.

Other processes and apparatus have recently been patented, but I regret that I am unable to mention them here.

Before leaving this part of the subject, I just give a very brief outline of the treatment of the Rangoon petroleum, as adopted by Price's Patent Candle Company. The process is that patented by Mr. Warren De la Rue. The oil is separated into light oil called Sherwoodle, chemically different, but having almost the same properties, as benzine; belmontine oil for lamps; lubricating oils; and belmontine, described as a superior quality of paraffin.

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## CHAPTER VII.

### PRODUCTS OF PETROLEUM.

KEROSOLENE.—SPIRIT.—BURNING OIL.—DANGEROUS LAMP OILS.—CASARTELLI'S APPARATUS.—ILLUMINATING POWER OF BURNING OIL.—LUBRICATING OILS.—LUBRICATING GREASES.—COKE.—WAX.

It has been shown that there are some five or six different products obtained from the crude petroleum, and these will now be described.

#### KEROSOLENE.

This is an extremely light volatile liquid, which first passes over when petroleum is distilled. It has a specific gravity of about  $\cdot 650$ , and a rather pleasant ethereal odour. It has been proposed as a substitute for chloroform, as it is found to possess anæsthetic properties. The article known as kerosolene was first obtained as a product in the manufacture of kerosene oil by the distillation of coal.

#### PETROLEUM "SPIRIT."

The petroleum spirit, known also by the name of "turpentine substitute" and "benzine," is a colourless highly volatile liquid, possessing generally a somewhat pleasant ethereal odour. The specific gravity of this article, as found in the market, varies from  $\cdot 700$  to  $\cdot 740$ . It is exceedingly inflammable, and evolves an inflammable vapour at ordinary temperatures. Great care should therefore be exercised in storing and using it that no flame is brought near it, or accidents may occur.

It is principally used for paint, as a substitute for turpentine, and, as far as I can learn, with very good results.

When properly prepared it is superior in many respects to turpentine; the paint flows more freely from the brush, it dries quicker, and does not possess so disagreeable a smell. I have likewise noticed that many specimens of spirit, as they evaporate, give to the paint a bright shining surface, very different to the dull heavy surface of paint made with turpentine; and it appears that as they evaporate they leave a shining bituminous varnish, which probably will be found advantageous in protecting the paint.

There is one objection which has been urged against the use of petroleum spirit for paints, and that is, that when used for light-coloured paints it gives them a brownish tint. This is owing to the presence of sulphur, which forms a dark sulphide of lead with the lead of the paint. This sulphur can be easily removed in the refining process.

Another objection which has been brought against petroleum spirit is, that it dries too quickly, so that in fact the paint dries almost before it leaves the brush. This is the fault of the manufacturer, who has, in distilling, stopped the collection of "spirit" at too early a stage, and consequently has collected only the more volatile portions.

Some manufacturers, on the other hand, commit the mistake of making too much spirit. They collect as spirit some portion of the distillate that properly belongs to the

burning oil, and the consequence is that the spirit is rendered oily, and does not dry sufficiently well to be used for paints.

A good sample of spirit should leave no permanent stain on paper which has been moistened with it.

From the results of experiments I have made, and from having ascertained the specific gravity of numerous samples of petroleum spirit pronounced by practical painters to work satisfactorily, it appears that the best specimens for paint purposes have a specific gravity between .725 and .735.

Another use for this spirit is for dissolving India-rubber, &c., for waterproof materials, and for this purpose it is said to answer admirably. It may likewise be used instead of benzole for removing grease spots from dresses, &c.

There can be no doubt that this product of petroleum is likely to prove a very useful article, and become extensively used. There is, however, one point which must be mentioned, and which cannot be too strongly enforced upon the attention of refiners, and that is the necessity which exists for a more uniform product; for, as before mentioned, the specific gravity of spirit varies at the present time to a considerable extent, and this materially interferes with the use of it, as the consumers can never rely upon procuring from time to time spirit of the same quality.

#### BURNING OILS.

The next product of petroleum is the burning oil, used for illuminating purposes. It is sold under the names of photogen, kerosine, mineral or American paraffin oil, petroleum burning oil, &c.

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Its specific gravity varies from .780 to .825, and there is likewise considerable difference in its appearance. Most of it is either colourless or of a delicate yellow tint, but some samples possess a darker colour. It is now extensively used as a lamp oil, and gives an excellent bright light.

Objections have been made against it that it is unsafe and liable to explode, owing to its giving off inflammable vapour at temperatures to which it is liable to be exposed during its use, and by many persons it has been strongly condemned on this account. It is a mistake, however, to attribute explosive properties to the properly prepared petroleum burning oils. *These oils are not dangerous, and can be used with perfect safety.*

Unfortunately there are some oils sold as petroleum lamp oils which are not safe, and it is much to be regretted that such is the case. This is principally owing to carelessness in the refining process, sufficient care not being taken to separate the lighter products from the lamp oils. Manufacturers who send out such oils are guilty of gross neglect, for there is no difficulty whatever in preparing *perfectly safe* lamp oils from petroleum. No oil should be sold as a lamp oil which evolves inflammable vapour under 100° F.; indeed, most of the best samples now made do not give off such vapour under 130° F.

Another cause which may produce a dangerous lamp oil is the addition to it of petroleum spirit. Not long since I was told of a case of this kind. A lamp oil of greater specific gravity than usual was found not to burn well, it being too dense to rise properly in the wick. In

order to reduce the specific gravity, and make it burn better, the person in whose possession it was mixed with it a quantity of spirit, and thus an exceedingly dangerous lamp oil was formed. Such a proceeding could only arise through ignorance, and it is only mentioned here in order to caution other persons from doing a similar thing.

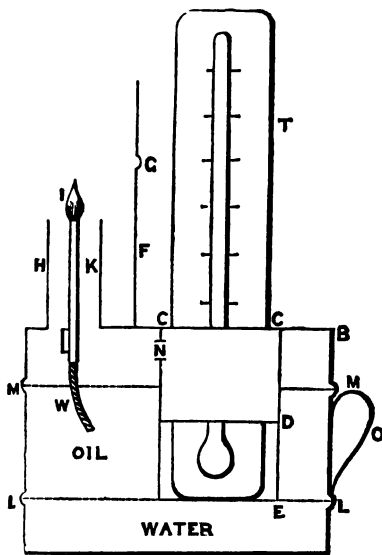
In August, 1862, I examined a number of samples of petroleum lamp oil obtained at shops in Liverpool and Birkenhead, and I found out of twelve samples six only that could be considered perfectly safe, and one of them was extremely dangerous.\*

Since then (in January, 1863) I have examined several other samples procured at the same shops; but of fifteen samples only two gave off inflammable vapour under 100° F., one at 85°, the other at 96°, and these samples might be used in most cases without danger. During the present month, July, 1863, I have purchased nine other samples; but none of these evolved inflammable vapour under 112° F. I am, therefore, led to believe that the dangerous lamp oils are on the decrease, probably more care being exercised in the preparation of the oils used for burning.

It is of importance that a ready means should be possessed of ascertaining whether or not a lamp oil is or is not dangerous. The specific gravity of the oil has been proposed as a test, but this cannot be relied on. No oil should be used as a lamp oil which takes fire immediately on contact with a lighted match.

\* See *Pharmaceutical Journal* for November, 1862.

Amongst other methods which have been proposed for testing lamp oils, is a very ingenious apparatus invented by Mr. Anthony Casartelli, of South Castle Street, Liverpool. It is simple in its operation, and sufficiently accurate in its results for all practical purposes. The following is a description of this instrument:—



A

FIG. 13.

A is a cup to contain the oil to be tested, having a tight-fitting cover B. T a thermometer passing through the cover. C D is a rectangular tube, supporting the thermometer and dipping below the surface of the oil M M. N a small hole in the tube C D, above the oil. D E a hanging shelf, attached to C D, on which the thermometer rests. K is a small tube through which a wick,

W passes. H a tube surrounding the wick tube open at both ends. F is a screen to protect the thermometer from the flame I. O a handle to the cup.

The instrument is used as follows :—Remove the cover from the cup and fill it with fresh water to the lower bead L ; then pour in the oil to be tested until it reaches the upper bead M. Insert a piece of cotton string in the small tube K for a wick, putting a drop or two of oil on the upper end ; and replace the cover, pressing it well down. Place the thermometer in the opening C C, and cause it to rest on the shelf E. Next light the small wick, and adjust it so that the flame shall just reach the level of the bead G, on the screen F. Now place the apparatus on a stand over a spirit or oil lamp. As soon as the temperature of the oil rises to the point at which it evolves inflammable vapour, this vapour mixes with the air in the apparatus, and coming in contact with the flame I, takes fire, and causes a slight explosion which blows out the flame. By noticing the temperature, as shown by the thermometer, at which this effect is produced, the point at which the oil becomes explosive is ascertained.

There is another method more simple, and when carefully performed, a very accurate one :—Place a small quantity of oil in a saucer and put it over a lamp. Let the bulb of a thermometer dip into the oil. Then apply a lighted match to the surface of the oil, and notice the temperature at which it first inflames. The oil should be kept well stirred, so that every portion of it may possess the same temperature.

The specific gravity of a good burning oil should not exceed  $\cdot 819$  or  $\cdot 820$ , for, if the gravity is higher than this, the oil does not rise readily in the wick, and consequently burns badly. The specific gravity of the best samples I have examined ranged from  $\cdot 790$  to  $\cdot 810$ .

The following table, extracted from a lecture on Artificial Light, by Dr. Frankland, published in the *Chemical News*, of February 21, 1863, shows the illuminating power of petroleum as compared with the light given by other substances. The table is arranged to show the quantity of other substances required to give the same amount of light as would be obtained from one gallon of Young's paraffin oil:—

Young's paraffin oil	-	-	-	1.00	gallon.
American rock oil, No. 1	-	-	-	1.26	„
„ „ No. 2	-	-	-	1.30	„
Paraffin candles	-	-	-	18.6	pounds
Sperm do.	-	-	-	22.9	„
Wax do.	-	-	-	26.4	„
Stearic do.	-	-	-	27.6	„
Composite do.	-	-	-	29.5	„
Tallow do.	-	-	-	39.0	„

The next table gives the comparative cost of light obtained from different illuminating materials, as compared with the light of twenty sperm candles, each burning ten hours, at the rate of 120 grains per hour:—

	s.	d.
Wax	7	2½
Spermaceti	6	8
Tallow	2	8

	s.	d.
Sperm oil - - - - -	1	10
Coal gas - - - - -	0	4½
Cannel gas - - - - -	0	3
Paraffin candles - - - - -	3	10
Paraffin oil - - - - -	0	6
Rock oil - - - - -	0	7½

It is not stated what American rock oil is alluded to in the above table, or whether it is the crude or refined article.\* We may, however, presume that it is the refined.

The following table, compiled from the results of my own experiments, lately made, show the relative amount of light obtained from an equal quantity of various materials:—

Material used.	Light from equal amount of material.
Petroleum lamp oil, sp. gr. ·800	2·25
„ „ „ ·812	2·15
„ „ „ ·790	2·50
Paraffin oil .....	2·60
Paraffin candles—sixes .....	1 60
Tallow „ „ .....	·60
Composite „ „ .....	·80
Sperm „ „ .....	1·00

\* The Editor of the *Ironmonger* states that upon inquiry he finds that the oils employed were of an inferior quality, as shown by the fact that they ignited at very low temperatures.

The table given below is extracted from *Circle of Sciences*, vol. i., page 421:—

Description of Oil.	Price per Gallon.		Intensity of light by Photo-meter.	Amount of light from equal quantity.	Cost of an equal quantity of light in decimals.
	s.	d.			
Petroleum .....	2	0	13·7	2·60	2·00
Sperm .....	7	6	2·0	·95	20·00
Camphine .....	5	0	5·0	1·30	10·00
Rape or Colza .....	4	0	2·1	1·50	6·50
Lard .....	4	0	1·5	·70	14·50
Whale .....	2	9	2·4	·85	8·25

There is a large variety of lamps sold for burning petroleum lamp oil, and most of them may be obtained at a very cheap rate, from 1s. and upwards. In fact, both the oils and the lamps are so cheap as to be within the reach of every person.

#### LUBRICATING OILS.

There are several varieties of lubricating oils obtained from petroleum; but with the exception of some of the heavier and thicker kinds of crude oil, which are sometimes used for lubricating heavy machinery, they are all obtained from the heavier portions of the distillate from the crude oil, from which the lamp oil and spirits have been separated. The best variety is that which separates after the burning oil has passed over, and before any tarry or pitchy matter makes its appearance. This portion of the distillate is frequently separated into two portions—one called “heavy,” and the other “light,” lubricating oil.

Another kind of lubricating oil is the whole of the residue which remains in the retort after the lamp oil has distilled over.

The specific gravity of these oils ranges from .830 to .900. Many of them contain paraffin, which separates in beautiful feathery crystals when the oil is exposed to a low temperature. This paraffin is frequently separated from the liquid by a process presently to be described.

These oils are very good substitutes for the different animal and vegetable oils used for lubricating purposes, and are becoming extensively used. Some oils made from petroleum which I have examined, when tested on a small scale, were found to be fully equal in lubricating power to the best sperm oil. These were supplied to me by Messrs. Holt and Banner. It should be mentioned, however, that petroleum lubricating oils, unless of high specific gravity (.880 or .890), are not suited for some kinds of machinery—as, for instance, some portions of the machinery used in the cotton manufacture, which are worked at a very high rate of speed. The heat produced is sufficient to volatilize the oils.

#### LUBRICATING GREASE.

This substance is procured by stopping the distillation process before all the oily matter has passed over, and the result is a greasy tarry matter, instead of the coke which is left when the distillation is carried to the full extent. This greasy matter is well adapted for lubricating heavy machinery, cart wheels, &c.

A very useful product is obtained by mixing the petroleum grease with animal fats, palm oil, &c.

#### COKE.

When the distillation of the petroleum is carried to the full extent, there is left a residue of compact coke. As an article of merchandise this coke is at present valueless, but many refiners use it as fuel, for which purpose it is tolerably well adapted.

#### PETROLEUM WAX (PARAFFIN).

A beautiful clear white waxy substance, resembling spermaceti in appearance, is obtained from petroleum, and appears to be identical with the paraffin obtain by Reichenbach in the distillation of coal. It is obtained by placing the heavier portions of the oil in a tank, and subjecting them to a temperature between 30° and 40° F., when the paraffin crystallizes out on the sides of the tank in beautiful white scales. The oil is then withdrawn, and the paraffin collected and submitted to powerful pressure to remove a further portion of oil. It is purified by agitating it in a melted state with sulphuric acid, afterwards washing with hot water and solution of caustic alkalies. It is then again pressed, and finally melted and run into moulds. It is principally used in the manufacture of candles. These are superior to wax, sperm, and tallow candles, not only in appearance, but likewise in illuminating power. They are also cheaper than either wax or sperm candles.

This wax, although called paraffin, is probably not all

paraffin, but most likely consists of a mixture of solid hydro-carbons allied to that substance.\* Pure paraffin is a clear white waxy substance, without taste or odour; it fuses at 110° F. (43° 8 C.). It volatilizes at higher temperatures without decomposition, and burns when strongly heated, with a luminous jet smoky flame. It is quite insoluble in water, slightly soluble in alcohol, freely in ether, and mixable in all proportions, when melted, with both fixed and volatile oils. The most energetic chemical agents fail to exert any action on it, nor is it known to combine in any definite manner with any other body, whence its name, from *parum affinis*.

Much of the petroleum wax is now to be found in the market in the unrefined state. It is generally of a yellow colour, something like bees' wax, but some of it is much darker. I am told that it has been used, amongst other purposes, for adulterating bees' wax.

\* Recent experiments I have made, and which I intend shortly to publish, show that the petroleum wax called paraffin, instead of being one single substance, is a mixture of at least three or four solid hydrocarbons.—A.N.T.

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## CHAPTER VIII.

### OPPOSITION TO THE INTRODUCTION OF PETROLEUM.

SOURCES OF OPPOSITION.—OBJECTIONS ON ACCOUNT OF EXPLOSIVE PROPERTIES.—ACT OF PARLIAMENT.—OPPOSITION ON ACCOUNT OF SMELL.—MEETING AT BIRKENHEAD.—CAUSE OF NUISANCE.—CONSEQUENCES OF OPPOSITION.

LIKE many other articles, petroleum met with much opposition when first introduced as an article of commerce and general use, and, at the present time, this opposition is still largely felt. This might have been expected, as there cannot be a doubt that petroleum, being so valuable for illuminating, lubricating, &c., must greatly interfere with the sale of other articles employed for the same purposes, the dealers in which raise every objection they possibly can to an article that so seriously injures their own trades. In fact there is no denying that the introduction of petroleum has been considerably opposed by these parties.

Any further opposition it has met with has emanated chiefly from a lot of silly alarmists, a class of men who are so easily frightened that they appear to live in a chronic state of fright, having always some cause of alarm before them. These men got to learn that petroleum was exceedingly inflammable and explosive, and

that it had a disagreeable odour. They also heard of accidents occurring from explosion at one place, and of persons being made ill by the disagreeable smell at another; and, instead of inquiring how it was these effects were produced, they immediately conclude that petroleum is such an extremely dangerous and disgusting article, that if allowed to come near them they must be all blown to pieces by explosion, or poisoned by a noisome stench, forgetting that there are many other things of a far more dangerous and disagreeable nature constantly in use every day, and which frequently cause accidents, although they are on the whole so decidedly useful as not to be dispensed with without considerable inconvenience.

#### OBJECTIONS TO THE EXPLOSIVE PROPERTIES OF PETROLEUM.

With regard to the explosive properties of petroleum, it has already been shown that this article is not in itself explosive, but that it evolves an explosive vapour at ordinary temperatures, or at temperatures to which it is liable to be exposed whilst stored or in use.

Now, if we were not already acquainted with other articles possessing this very same property, and consequently were unable at once to find a remedy to prevent accidents, there might be some objection raised on this score; but it so happens that we have several other articles which are quite as dangerous in this respect, if indeed, not more so. Take for instance common naphtha, which is a liquid possessing similar properties to petroleum, and has frequently caused dangerous accidents, yet

it is extensively used for various purposes, but care is taken in its use to prevent the accidents which may otherwise occur. Common coal gas again is another instance. We have frequently examples of the dangerous effects of coal gas, not only when it causes explosions, but likewise of its fatal effects when respired for some time.

Dr. Taylor attaches considerable importance to the poisonous properties of coal gas; and states that there are reports of six deaths on record where persons have been killed by sleeping in rooms near to which there was a leakage of gas. Only a few months ago two young girls were killed by sleeping in a room in which an escape of gas took place, owing to the gas-pipe having been broken off by the weight of a dress which they had hung upon it before they went to sleep.

M. Fourdes found that an atmosphere containing one-thirtieth or even one-fiftieth part of coal gas, seriously affected animals.

It is also shown by the report of Captain Shaw, Superintendent of the London Fire Brigade, that 124 fires were caused by gas during last year, whilst only two were caused by naphtha or mineral oils.

Yet, notwithstanding this, we admit gas into our houses without the least hesitation, and instead of the use of it decreasing it increases to an enormous extent. We are aware of its dangerous properties, and, therefore, take precautions to prevent accidents.

So with petroleum, we know that the crude oil and the spirit yield an explosive vapour, and that consequently it is necessary to observe certain precautions in

storing and using them ; but that is no reason why its importation, sale, and use should be hampered by unnecessary restrictions, as at present.

The oil should be stored in well-ventilated buildings, so that any vapour which may escape may at once pass away ; and no lighted lamp, candle, or other *flame* should be allowed in the place in which it is kept.\* If these simple precautions are observed no danger can possibly arise in storing it. An excellent plan for building warehouses for storing petroleum in large quantities was suggested some time since by the Engineer to the Liverpool Dock Board. These warehouses were to have been built on the margin of the Great Float, at Birkenhead ; but for some reason or other this has been for the present abandoned. But there could not be any escape of vapour if the oil was placed in suitable vessels—in vessels made perfectly air-tight. Such vessels are easily procured, and a cask invented by Mr. David Cope, of Naylor Street, Liverpool, and called by him Cope's Patent Iron Drum, is already largely used for holding petroleum, naphtha, turpentine, &c. As it is admirably suited for the purpose, and effectually prevents escape of vapour, a short description of it is here given.

The framing or sides of the cask form a plain cylinder. The ends have their outer edges bent to a right angle, as shown in *fig. 15* ; these rest against the inside of the cylinder in the manner shown in *fig. 16*. Double hoops or chimbs (formed by machinery of Mr. Cope's inven-

\* This does not refer to the burning or lubricating oils, but only to the crude oil and petroleum spirits which evolve vapour at ordinary temperatures.

tion) are fitted over the framing or sides, and the inverted part of the end, as in *fig. 16*. One edge of the hoop rests on the flat surfaces of the ends, and the other is carried past a continuous line from the ends, thus securing solid metal chimbs having great strength to resist internal pressure and chimb blows. The various junctions are secured by "dipping" in the best soldering



Fig. 14.

materials, so that the interstices in the "landings" are certain to be filled up. The bunghole of the cask is effectually secured by a screw-cap. Fig. 14 shows this cask complete

It is hardly necessary to further state that a cask of this kind effectually prevents any leakage taking place.



Fig. 15.

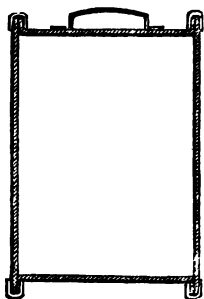


Fig. 16.

An Act of Parliament has lately been passed for providing "for the safe keeping of petroleum and certain products thereof that are dangerous to life and property

from their properties of giving off inflammable vapour at low temperatures."

This Act, although taking especial care to prevent accident from storing of petroleum in too close proximity to dwelling-houses, &c., does not in any way allude to the sale of dangerous lamp oils. As before stated (and it cannot be too strongly impressed upon the public), properly prepared petroleum lamp oils are perfectly safe; but there are some specimens of lamp oil which, from carelessness in their manufacture, are not safe, and the earlier such oils are entirely done away with the better. Other oils besides those made from petroleum are of this nature. Had the Act provided that a penalty should be inflicted on any person selling as a lamp oil any liquid which gives off inflammable vapour under 100° F., it might have had a good effect, as it would have caused greater care to be exercised in the preparation of lamp oils, and kept out of existence those that are liable to cause accident, of which there are still a few specimens in the market.

As it is, however, the Act is of little use except as an obstructive measure, which, by putting persons to unnecessary trouble in obtaining licenses, &c., tends to prevent the perfect development of a large and valuable trade.

It is to be hoped that, as the properties of petroleum and its products become better known, steps will be taken to alter or repeal this injurious law.

Already there is evidence that people are becoming convinced of the foolishness of regarding petroleum as being so extremely dangerous as it has been represented.

## 100 OPPOSITION TO THE INTRODUCTION OF PETROLEUM.

Insurance companies that have been charging from £7 7s. to £10 10s. on petroleum afloat from America, have now reduced their charge to £2 10s. In Belgium, the Minister of the Interior has declared that petroleum is not to be considered as one of the articles of inflammable merchandise which must be treated by special regulations as essentially dangerous.

### OPPOSITION TO PETROLEUM ON ACCOUNT OF ITS SMELL.

The next point of consideration is the opposition which has been raised against petroleum on account of its odour. This opposition has been very violent, and legal proceedings have been resorted to in more than one instance.

That the odour of petroleum is disagreeable cannot be denied, and there is no doubt that it may be the cause of serious nuisance, but it is not as bad as many people wish to make out.

The remarks made by some persons respecting the smell of petroleum are perfectly absurd and ridiculous. For instance, at a meeting held a short time since at Birkenhead, a gentleman said that the smell of guano and salted hides was eau-de-cologne and lavender water compared with the odour of petroleum. Such a "clap-trap" statement scarcely requires notice, as any person acquainted with the odour of the three articles must certainly own that the smell of salted hides, at any rate, is much more disgusting, and decidedly more unwholesome, than that of petroleum; but there are many persons who might be misled by such a statement, and

it is therefore thought well to notice it in this place, nonsensical as it is.

There is another point which should be mentioned connected with the Birkenhead meeting just alluded to. This meeting was held ostensibly for the purpose of considering what steps should be taken in reference to the proposed erection, by the Dock Board of Liverpool, of warehouses for storing petroleum on the banks of the Great Float. About fifty persons only attended the meeting. Instead, however, of its being a meeting of persons assembled for the purpose of impartially considering the question, it appeared to be a meeting concocted by a few individuals for the express purpose of opposing the introduction of petroleum into the port of Birkenhead. It is not intended here to enter into the question whether or not it was desirable that petroleum should be kept away from Birkenhead, but only to call attention to a disgraceful ruse practised at the meeting in question—a ruse which is a good sample of the practices which have been resorted to by interested persons in order to raise a strong opposition to petroleum. With the view, probably, of convincing parties who were doubtful on the subject that petroleum was a very disgusting article, some person or persons adopted means to fill the room in which the meeting was held with the vapour of Canadian petroleum; and several of the speakers who addressed the meeting endeavoured to lead their hearers to believe that the smell proceeded from a small *corked* half pint bottle (an ordinary sample bottle) which was standing on the platform.

The smell, most decidedly, did not proceed from the bottle alluded to. Either a large quantity of the oil had been sprinkled about the room, or some of it had been evaporated, and the room filled with the vapour: judging from the peculiar odour, &c., the latter is the most likely explanation. In this disagreeable atmosphere it could not be expected that the persons assembled could impartially consider the question before them.

Such practices cannot be condemned too strongly, as they are calculated to give a wrong impression, and unduly influence persons against an article which is certain to become of the greatest commercial importance. It is to such practices as the one just mentioned that much of the opposition to petroleum is owing.

The meeting just alluded to was presided over by a gentleman whose duty it was—holding as he does the office of Chairman of the Birkenhead Commissioners—to have seen that the proceedings were conducted properly, so that the interests of the town should not suffer; but, either knowingly, or through ignorance of the true nature of petroleum, he allowed the disgraceful proceeding I have mentioned to pass unnoticed by him, except by a mere jocular remark not at all indicative of disapproval. This meeting has no doubt in great measure prevented the erection of the storehouses, &c., for petroleum in the neighbourhood of Birkenhead, and the town has, therefore, probably lost one of the most important trades that could have been offered to her.

Since the meeting, petroleum has again occupied considerable attention in Birkenhead, many of the inhabi-

tants having been much annoyed by a strong smell of that article, which pervaded their houses for several days. Upon examination this smell was found to proceed from the sewers, and it was strongly suspected that another trick had been played by the opponents of petroleum, as it was thought that some of the oil had been purposely thrown into the sewers to cause a nuisance, and increase the opposition. Whether or not this was the case is not known, for, although the officials instituted rigorous inquiries, it has never been discovered how or from whence the oil got into the sewers. One thing is very certain, that there is not the least necessity for petroleum, in any shape whatever, entering the sewers; and if it had got there, through accident or design, from any of the petroleum works, or from premises upon which it was kept, it would in every probability have been discovered where it proceeded from. And, as far as regards the smell of the oil being an annoyance if placed on the spot proposed—on the borders of the Great Float—it is a perfect impossibility that any smell should be perceived in the town. In fact, no person who has carefully and impartially considered the question, would for one moment have any doubt about it. They could not help coming to the conclusion that in the first place if the oil was properly secured no smell could escape; and in the second, supposing that by negligent packing, &c., the odour did escape into the surrounding air, it would not be carried into the town, although it might be perceived to some slight extent in the *immediate* neighbourhood of the storehouses.

There is no doubt that the people of Birkenhead have

unnecessarily alarmed themselves. There have been for some time works for refining petroleum much nearer the town than the Great Float, but no unpleasant smell proceeds from them. I have frequently been in their neighbourhood, but could not perceive any odour of the oil; and what speaks strongly in support of this statement is, that dwelling-houses are being built in all directions in the immediate vicinity of the works.

The fact is undeniable that, although petroleum possesses an unpleasant smell, there need not be any nuisance caused by it. When stored in proper casks, which prevent leakage, any quantity of it may be kept in any place without any disagreeable smell being perceived.

The principal cause of the nuisance arising from petroleum is owing to its being placed in leaky casks and other unsuitable vessels. This was proved by the report of one of the officials of the Corporation of Liverpool, who was requested to examine into an alleged nuisance arising from storing petroleum in one or two places in the town. This gentleman reported that the nuisance complained of was caused entirely by the large amount of leakage of the petroleum from the vessels in which it was placed; this leakage, in some instances, actually amounted to as much as 25 per cent.

There is no doubt that this is really the case, and if proper vessels are used for holding the oil no nuisance can arise.

Mr. Forwood, a member of the Liverpool Dock Board, stated, at a late meeting of that body, that he had visited several of the principal petroleum stores, and amongst

them were some appropriated to the storage of Canadian petroleum, which it was known was of the most offensive character; but he passed through those stores with less inconvenience than he expected, and he found no odour within a few yards from the door, though these were sheds, and were not built for the stowage of petroleum, the only addition being the introduction of a few ventilators in the roof. He was also very much struck with the appearance of a stout man employed in guaging this petroleum, and he said that he slept well and ate well, and was anything but a proof of the injurious nature of petroleum.

So also in the case of petroleum refineries: any nuisance arising from them may be prevented by proper care and attention. Only let manufacturers understand that in many cases they may, by abating the annoyance, put so much more profit into their pockets, and we shall soon cease to hear of nuisance arising from petroleum works. The apparatus may be so arranged, and the process so conducted, as to prevent any escape of odour into the surrounding air.

One of the consequences of the absurd opposition which has saluted petroleum is that, instead of the crude oil being sent to this country to be refined, it is now to a much greater extent than formerly refined in America. This is proved by the fact that the importations of refined oil are now proportionally much larger than they were last year. We thus lose the advantage of an extensive manufacturing business.

## CHAPTER IX.

### TRANSPORT OF PETROLEUM FROM AMERICA.

**GREAT EXPENSE OF TRANSPORT.—CARRIAGE IN SHIPS.—IRON TANK VESSELS.—DELF AND GIBSON'S PATENT.—PUBLIC COMPANIES.—MR. KING'S PLAN FOR LOADING AND DISCHARGING PETROLEUM.**

ONE of the principal items in the cost of petroleum is the expense of transport. The cost of transit from the oil regions to the shipping ports may be put down as equal to from 300 to 400 per cent. on the original value of the oil, so that by the time the oil reaches this country—assuming the freight to be 8s. per barrel, which is the usual rate from New York—the price could not be less than 650 or 750 per cent. on the value of the oil at the wells. As, of course, it would assuredly follow that a reduction in the price of the oil would materially increase its consumption for the purposes it is already used for, and also allow of its being employed for other purposes besides, which its price—low as it is, comparatively speaking—now prevents, it is of much importance that the question of reducing the expense of carriage should be carefully attended to. Several plans are now in course of being carried out in order to facilitate the transportation of petroleum. In order to get the oil more readily and at less cost to the ports, the Great

Western Railway Company are about to construct a branch to the springs. A road to Dresden on the Sydenham river is also spoken of. Arrangements are making by the Grand Trunk Railway Company of Canada to carry petroleum in large iron tanks, placed on wheels, from the wells to Portland for shipment. The means at present adopted for transporting the oil from the springs to the port have already been described.

#### CARRIAGE OF PETROLEUM IN SHIPS.

The rate charged for carrying petroleum in ordinary vessels is enormously high on account of its inflammable nature and disagreeable smell. It has been found that, owing to the strong odour, general merchandise cannot be carried in vessels which also carry petroleum, as many articles, such as for instance, grain and flour, become impregnated with the odour, and are consequently damaged to some extent.\* It therefore follows that the oil must be brought to this country in vessels specially built and set apart for the purpose.

A plan for carrying petroleum in ships in iron tanks has been adopted by Mr. Gibson, of Ramsey, Isle of Man, and is now being used by other parties.

The vessels are simply divided into compartments, made of iron, forming a series of tanks, which are also made air-tight. When the vessel is loaded the tanks are filled perfectly full of oil, so that there may be no

\* This is principally owing to the oil being placed in leaky casks. It is with difficulty that a sufficient number of casks can be supplied at the wells, and a large number of those used are quite unfit for the purpose.

movement of the liquid to interfere with the sailing of the vessel, and also that no explosive mixture of air and petroleum vapour may exist in the tanks. To allow for the expansion and contraction of the liquid from changes of temperature, and also to prevent escape of vapour, a simple contrivance has been invented by Mr. F. D. Delf, of Hardman Street, Liverpool. This invention has been patented by Mr. Delf in conjunction with Mr. Gibson. The principle of the invention is as follows :—The vessel holding the petroleum is fitted with a bent tube or siphon, one end of which dips into water contained in another vessel. In case of expansion of the liquid by a rise of temperature, any pressure is exerted upon the layer of water, a portion of which is forced up the tube ; but neither any vapour nor liquid petroleum can escape, and as the liquid again contracts, the water resumes its former level. Mr. Gibson is just now despatching two vessels to America for the purpose of bringing back petroleum.

Companies have lately been formed for the purpose of importing petroleum from America.

One Company lately incorporated is called the “Petroleum Trading Company, Limited.” The capital of this Company is £100,000 in 10,000 shares of £10 each, with power to increase to £200,000.

The following is extracted from their prospectus :—  
 “This Company has been formed for the purpose of importing into Europe (on a scale capable of meeting the rapidly increasing demand) petroleum from the natural wells of Pennsylvania, and elsewhere. . . . .

It is proposed to carry petroleum chiefly in iron-tank vessels, specially built for the purpose, and so constructed as to transport it in bulk or barrels, to suit the requirements of the trade; but the vessels are also adapted for general cargoes, so that, should any more profitable trade present itself from time to time, the Directors will be able to avail themselves of it. These ships, being constructed in compartments, formed by transverse bulk-heads and a longitudinal partition, are safer than those of ordinary build; and it is believed that by this system the cost of conveying the petroleum will be reduced to the lowest rate. Owing to the difficulties in the carriage of petroleum in ordinary ships the rates of freight and insurance are enormously high, so that a large margin of profit on the tank-ships, over and above ordinary ships, must be maintained. Two tank-ships are in course of construction, and will be completed as rapidly as possible, and one iron vessel is now nearly ready for dispatch."

The Company is supported by some of the leading persons connected with the Atlantic and Great Western Railway, whose line establishes a direct communication between the wells and New York, *via* the Erie Railway.

A Company of this kind if properly managed (and it does not appear that there can be much doubt on this point, as the directors are all of them men of business and favourably known in the commercial world), cannot fail to be highly successful, and must, by introducing greater facilities for transporting the oil, exert a very beneficial effect upon the trade.

Another Company was formed in the latter part of last

year, called the "Canadian Native Oil Company, Limited," with a capital of £100,000, in 20,000 shares of £5 each. This Company, in addition to undertaking the transportation of the oil from the wells to Europe, likewise proposes to conduct the refining of it.

Another Company, established in America, is the "American Petroleum Company," with a capital of 500,000 dollars. The Company possesses the royalty of numerous wells, and also extensive lands in the oil districts.

A Company called "The General Petroleum Company," has also lately been started.

Other Companies besides those just mentioned are also spoken of; and, amongst others, there is one proposed for the purpose of working the petroleum springs in the vicinity of the Caspian Sea.

#### MR. J. T. KING'S PLAN FOR LOADING AND DISCHARGING PETROLEUM.

The following is a plan suggested by Mr. J. T. King, of Clayton Square, Liverpool, for loading and discharging petroleum without the escape of vapour, disagreeable odour, &c.:—

The vessels for carrying the petroleum are built expressly for that purpose, and are fitted with iron tanks. Upon the quay at which the vessel is loaded is placed a large closed cistern for holding a stock of oil. This cistern is fitted with taps, both at top and bottom, and to these taps a sufficient length of leather tubing is joined. The vessel is brought to a spot convenient to the store cistern, and both the leather

tubes are connected with the ship tanks, and the taps then opened. As the oil runs into the vessel through the bottom tube it displaces a corresponding volume of air or vapour, and this, instead of escaping into the surrounding atmosphere, is conducted by the other tube into the store cistern, and takes the place of the oil which has run out of it. In discharging the vessels the tanks are connected by means of leather tubing with other store tanks on the quay, and the oil pumped out of the vessel into these store tanks, all escape of vapour, &c., being prevented in the same manner as in loading.

To allow for expansion and contraction of the liquid from change of temperature during the voyage, the tanks are to be fitted with Delf and Gibson's patent apparatus, already described. The plan just described is also suitable for filling and emptying casks, &c., the casks being connected with the cistern in the same manner as the ship tanks.

I am not aware that Mr. King has taken any steps to get his plan adopted, but it is very evident that something of this kind will be used sooner or later.

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## CHAPTER X.

### MISCELLANEOUS.

THE following are a few miscellaneous particulars which I have thought well to insert here :—

*Table showing Export of Crude and Refined Petroleum from New York for the Years 1861 and 1862.*

To	1862. Galls.	1861. Galls.	To	1862. Galls.	1861. Galls.
Liverpool .....	1,781,377	187,254	Australia .....	233,699	168,365
London .....	1,133,399	115,644	Otago, N. Z. ....	7,850	—
Glasgow .....	24,181	276,977	Sydney, N. S. W. ..	113,750	—
Dublin.....	195	—	Brazil .....	54,967	5,882
Cork.....	299,356	—	Mexico .....	18,616	3,702
Havre .....	794,221	73,716	Cuba .....	213,686	150,703
Marseilles .....	135,765	1,600	Argentine Republic..	7,390	4,300
Bordeaux .....	200	—	Cisplatine Republic..	13,227	206
Cette.....	2,700	80	Chili .....	17,000	—
Dieppe.....	61,692	—	Peru .....	56,011	—
Antwerp .....	823,090	5,671	British Guiana ....	9,396	3,035
Bremen .....	452,522	32,112	British W. Indies ..	18,888	3,719
Hamburg.....	229,384	42,348	British N. America..	2,948	2,636
Rotterdam .....	16,938	640	Danish W. Indies ..	4,102	1,770
Stockholm .....	81,960	—	Dutch W. Indies ....	7,117	—
Gibraltar.....	157	200	French W. Indies ..	2,332	—
Palermo .....	3,990	—	Central America....	1,764	—
Genoa and Leghorn	21,000	62	Hayti.....	4,856	964
Lisbon .....	—	58	Venezuela .....	1,094	610
China and E. Indies	3,970	400	New Granada .....	37,058	15,552
Africa .....	655	445	Porto Rico .....	25,244	13,925
Canary Islands....	1,296	—			
Madeira .....	430	—	Total gallons ....	6,720,273	111,2076

Besides this, the shipments to California were very considerable.

#### Total Export in 1862.

From New York .....	6,720,273	Gallons.
" Boston .....	1,071,160	"
" Philadelphia.....	2,800,978	"
" Baltimore.....	174,830	"
" Portland .....	120,520	"
	<hr/>	
	10,887,701	

*Exports of Petroleum from the United States during the first half-year of 1863 as compared with 1862. (Extracted from the "Philadelphia Coal-Oil Circular, and Petroleum Price Current.")*

	Gallons—1863.	1862.		
Acapulco .....	700		Increase	700
Africa .....	3,870	345	"	3,525
Alicante .....	18,000		"	18,000
Amsterdam .....	200		"	200
Antwerp .....	1,482,593	127,234	"	1,355,859
Argentine Republic .....	13,850	2,540	"	113,10
Arroyo, P. R. ....	500		"	500
Australia .....	416,904	210,940	"	205,964
Bahia .....	6,000		"	6,000
Barbadoes .....	33,335	1,090	"	32,245
Belgium .....	125,174		"	125,174
Bombay .....	7,000	300	"	6,700
Bordeaux .....		200	Decrease	200
Brazil .....	89,143	15,942	Increase	73,210
Bremen .....	899,633	21,770	"	877,863
British Guiana .....	14,692	5,941	"	8,751
British Provinces .....	80,925	1,000	"	79,925
Buenos Ayres .....	32,000	1,000	"	31,000
Central America .....		2,055	Decrease	2,059
Calcutta .....	5,000	1,000	Increase	4,000
Callao .....	21,000		"	21,000
Canary Islands .....		160	Decrease	160
Cape of Good Hope .....	3,500	2,000	Increase	1,500
Cape Verde .....	10		"	10
Cardenas .....	30,210		"	30,210
Cette .....		2,700	Decrease	2,700
Chilli .....	41,440	16,800	Increase	24,640
China .....	15,314	1,000	"	14,314
Cisplatine Republic .....	99,145	3,389	"	95,756
Cienfuegos .....	410		"	410
Constantinople .....	3,500		"	3,500
Cork .....	749,948	170,411	"	579,537
Cuba .....	297,801	105,328	"	91,973
Dieppe .....	46,000		"	46,000
Dominica .....	200		"	200
East Indies .....	200	250	Decrease	50
Falmouth .....	389,108		Increase	389,108
Fayal .....	3,990		"	3,990
Flores .....	467		"	467
France .....	659,643		"	659,643
Genoa .....	140,753		"	140,753
Gibraltar .....	178,312	117	"	178,196
Glasgow .....	188,807	18,206	"	170,601
Grangemouth .....	287,272		"	287,272
Hamburg .....	968,177	118,997	"	844,180
Havana .....	44,562		"	44,562
Havre .....	910,093	391,618	"	518,475
Hayti .....	16,997	3,097	"	13,900
Honduras .....	940		"	940
Ireland .....	110,400		"	110,400

	Gallons—1863.	1862.		
Jamaica .....	1,000	—	Increase	1,000
Kingston .....	4,462	—	"	4,462
Kurachee .....	2,000	—	"	2,000
Laguayra .....	8,480	—	"	8,480
Leghorn .....	31,440	—	"	31,440
Lisbon .....	3,600	—	"	3,600
Liverpool .....	3,912,818	1,656,893	"	2,225,925
London .....	2,129,699	1,102,877	"	1,026,822
Malaga .....	120	—	"	120
Marseilles .....	672,470	51,735	"	610,735
Martinique .....	195	50	"	135
Matanzas .....	5,331	—	"	5,331
Mauritius .....	1,000	—	"	1,000
Mayaguez .....	2,050	—	"	2,050
Mexico .....	36,199	3,456	"	32,743
Monte Video .....	48,849	—	"	48,849
New Granada .....	84,773	14,232	"	70,541
New Zealand .....	7,180	—	"	7,180
Oporto .....	2,139	—	"	2,139
Otago .....	3,500	7,850	Decrease	4,350
Palermo .....	42,475	3,990	Increase	45,465
Pernambuco .....	1,620	—	"	1,620
Peru .....	226,125	2,6	"	223,145
Ponce, P.R. ....	1,540	—	"	1,540
Porto Rico .....	41,336	18,184	"	23,152
Port Elizabeth .....	250	—	"	250
Port Spain .....	3,924	—	"	3,924
Queenstown .....	91,391	126,450	Decrease	35,059
Rio Janeiro .....	70,997	4,100	Increase	66,897
Rotterdam .....	482,159	18,091	"	464,068
Rouen .....	65,003	—	"	65,003
San Andreas .....	50	—	"	50
San Blas .....	10	—	"	10
Sandwich Islands .....	—	2,400	Decrease	2,400
Scotland .....	570,913	—	Increase	570,913
Shanghai .....	250	—	"	250
Smyrna .....	5,710	—	"	5,710
South America .....	—	300	Decrease	300
St. Jago .....	1,120	—	Increase	1,120
St. Jago de Cuba .....	2,380	—	"	2,380
St. John's, P.R. ....	9,435	—	"	9,435
St. Lucie .....	150	—	"	150
St. Thomas .....	3,819	40	"	3,419
Stockholm .....	—	41,460	Decrease	41,460
Surinam .....	505	—	Increase	505
Trinidad .....	1,480	—	"	1,480
Turks Island .....	42	180	Decrease	136
Venezuela .....	12,223	204	Increase	12,019
West Indies (British) .....	65,907	16,743	"	49,164
— (Danish) .....	31,929	3,135	"	28,794
— (Dutch) .....	4,751	1,850	"	2,901
— (French) .....	6,757	950	"	5,803
— (Spanish) .....	—	9,103	Decrease	9,107
Total gallons .....	17,056,049	4,335,389	Increase	12,720,660

For the following particulars I am indebted to Messrs. Holt and Banner :—

*Exports of Petroleum from all the American Ports during the Year*

1861 - - - - - 37,082 barrels.

1862 - - - - - 362,593 „

1863 up to July 4th - - - 568,535 „

To England during the year 1863 up to July the 4th, 245,753 barrels.

So that the quantity of oil imported into this country during the past half-year, is equal to two-thirds of the whole of the petroleum exported from America during last year. This fact in itself is sufficient to show the importance and rapid growth of the trade.

The following table shows the prices of petroleum and products in Liverpool, during the last fifteen months :—

		CRUDE OIL.		REFINED OIL.		SPIRIT.	
		Per Tun.		Per Gallon.		Per Gallon.	
In May,	1862....	£ 8	0 to £10 10	1/6	to 1/9	—	—
„ June,	„ ....	9	0 „ 11 0	1/6	„ 1/9	—	—
„ July,	„ ....	10	15 „ 12 0	1/9	„ 2/-	1/10	to 2/-
„ August,	„ ....	11	10 „ 12 10	2/-	„ 2/3	1/8	„ 2/-
„ September,	„ ....	12	10 „ 16 10	2/-	„ 2/3	—	—
„ October,	„ ....	16	0 „ 20 0	2/4	„ 2/5	2/2	„ 2/3
„ November,	„ ....	18	0 „ 20 15	2/3	„ 2/5	—	—
„ December,	„ ....	20	0 „ 23 0	2/3	„ 2/10	3/-	„ —
„ January, 1863....		18	0 „ 21 10	1/9	„ 2/5	2/3	„ 2/6
„ February	„ ....	15	0 „ 17 10	1/7	„ 1/8	1/10	„ 2/-
„ March,	„ ....	12	0 „ 13 0	1/3	„ 1/7	1/6	„ 1/9
„ April,	„ ....	11	10 „ 14 0	1/5	„ 1/10	1/6	„ 1/9
„ May,	„ ....	14	0 „ 16 0	1/9	„ 2/-	1/6	„ —
„ June,	„ ....	16	0 „ 17 0	1/10	„ 1/11	1/3	„ 1/4
„ July,	„ ....	17	0 „ —	2/-	„ 2/5	1/3	„ —

These prices refer to Pennsylvanian petroleum.

*•Persons and Capital employed in the Petroleum Trade in the United States.*

The number of persons employed in this trade in the United States alone is between 7,000 and 8,000; and the amount of capital invested in the various branches of the trade is estimated at £2,000,000.

DIRECTIONS FOR THE USE OF LAMPS FOR PETROLEUM  
AND OTHER MINERAL OILS.

The following recommendations for the use of these lamps have been issued by the Board of Health, at Brussels; and as they are exceedingly good I have inserted them here:—The lamp should always be kept hermetically closed; for whenever there is an opening that admits a direct communication between the oil-holding receptacle and the flame, the lamp ought not to be used, as an explosion may ensue. The receptacle may contain more petroleum than is sufficient for one burning, and should be made of glass or other transparent material, so that the quantity of liquid in it may be easily ascertained. The foot of the lamp ought to be broad and heavily weighted, so as to give it greater stability, and prevent its being easily upset. Care should be taken, before lighting the lamp, to see that there is a sufficiency of petroleum in the receptacle, and should it, nevertheless, be consumed earlier than expected or required, the flame must be first extinguished, and time allowed for the lamp to cool, before refilling and lighting it again.

NOTE TO CHAPTER IV.—Since this chapter was in type, MM. Pelouze and Cahours have announced the discovery by them of four other hydrocarbons in petroleum, in addition to those mentioned at page 41. These are  $C_{24}H_{50}$ , hydride of lauryle;  $C_{26}H_{54}$ , hydride of cocinyle;  $C_{28}H_{58}$ , hydride of myristyle; and  $C_{30}H_{62}$ , not yet named. They also state that they have not been able to detect benzole or any of its homologues in petroleum. (See *Chemical News*, July 25th, 1863, page 44.) This corroborates my remarks at pages 27 and 42.—A. N. T.

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MESSRS. GILBERT AND GIBSON have also forwarded to us samples of a very superior mineral turps, perfectly colourless, without any nauseous odour, and so pure, that a portion spilt on the whitest paper evaporates without leaving the slightest stain or trace of odour. This is the best specimen of mineral turps that has been sent to us for examination.

*From Oil Trade Review.*



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